"PHYSICO-CHEMICAL & BIOLOGICAL CHARACTERISTICS OF MANDAKINI IN SATANA DISTRICT (M.P.)"

THESIS

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CONTENTS

PREFACE

Water is **"Boon"** for living being but because of our recklessness it is being considered as a water crisis on the global level that's why Government of India has declared 2008 as water year. Many programs are being carried-out under this, like-water harvesting etc.

The right uses of water is more important, the lack of aquatic environment is also a great cause in India, missuse of water resources has come out as a result of decreasing water resources, better improvement of water resource is necessary along with human interaction of water body.

Water quality of many river systems is getting rapidly digressed due to massive discharge of industrial wastes, insecticides, domestic sewage, flyash, mine drainage and surfactants etc., mass of the rivers have been unmindfully used for the disposal of domestic wastes for beyond their assimilative capacities people use sort of heavily polluted water.

To prevent the same condition of Mandakin River the programme of water preservation should be started immediately by the Government.

This thesis provide base line information for physico-chemical and biological studies of Mandakini River for the improvement of drinking water quality, along with its ecology to promote environment. It has 7 Chapters in which every attempt has been made to express clearly almost all the aspects of the river in a simple and lucid way.

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CERTIFICATE

It is hereby certified that the thesis entitled **"Physico-Chemical & Biological Characteristics of Mandakini in Satna District (M.P.)"** is being submitted to the Bundelkhand University, Jhansi (U.P.) by Anjali Gupta for the award of the degree of doctor of philosophy in Zoology. She worked under my supervision and guidance and the candidate has put in an attendance of more than two years with me.

To the best of my knowledge and belief the thesis, embodies the work of the candidate himself. It fulfills all the requirement of the ordinance relating to the requirement of the ordinance relating to the Ph.D. degree of the University.

Thesis is standard one both in the respect of contents and language. It is referred for the evaluation by the examiners.

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DECLARATION

I hereby declare that the thesis entitled **"Physico-chemical & biological characteristics of Mandakini in Satana District (M.P.) "** is completed by me under the excellent guidance and supervision of Dr. K.V. Singh Ex Reader and Head Department of Zoology, Pt. J.N.P.G. College, Banda (U.P.) It is submitted to the Bundelkhand University, Jhansi (U.P.) in fulfillment of the requirement for the award of the degree of Ph.D. This thesis is my original piece of work. Thesis or any part of it has not been previously published or submitted for the award of any degree.

As regards the literature concerned Journals, books etc. were consulted in libraries of C.S.A. Kanpur University and University of Lucknow & Allahabad University, Dr. H.S. Gaur University Sagar.

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INTRODUCTION

INTRODUCTION

The Environment has been an increasing focus for the last few years, all over the world and more so in India. It is probably not a better and older ethics of sustainable development. The environment is very important not only for the present generation but also for future generations. The relationship of man with the environment is necessarily Symbiotic, the equilibrium between the two must be maintained at all cost. Indian culture has endorsed the fact that the life owns its ixistence on the earth, and throughout dependant upon a neat balance among the various elements of the earth.

Nature is beautiful balanced and each small thing in it has own place, its duty and utility. Its five elements Agni, Akash, Jal, Vayu and Dharti have been worshipped as Gods, believing that the whole existence rests on nature's equilibrium. But the pollution disturbes the Eco- balance destruction of nature, its natural beauty, serenity and natural resources are results from ignorance, greed and lack of people pions responsibility.

Environmental pollution affects the life of our surroundings, wholly or largely as by- product of man's actions, through direct or indirect effects of the changes in energy patterns, radiation levels, Physical and chemical causes and abundance of organism these changes may affect man directly or through his supplies of water and agriculture and other biological products his physical objects his physical objects for recreation and appreciation of nature.

Now the world countries have given a serious thought to the great problem of environmental pollution. Many human problems are also due to missmanagement of environment created by man himself.

Today some people who are not at all mindful conscions about the serious consequences of environment degradation. Even some of the vested interests see more good in destroying the environment rather than in conserving it in their own interest. In the present age of unplanned and unsystemic urbanization and industrialization are giving rise to serious problem of pollution Air, Water, and soil are the inevitable components of environment on which human life is dependent.

Environmental Pollution Panel of U.S. President's science Advisory Commitee has been constituted in 1965. WHO (1971) reported environmental pollution as " Limited to situation in which the outdoor ambient atmosphere contains meterials in concentration which are harmful to man."

"The Chipko Movement" for conservation of trees by Dasholi Gram Swarajya Mandal in Gopeshwar or the "Narmada Bachao Andolan" Organized by Kalpavriksh, are some of the instances where NGO's have played a landmark role in the society for conservation of environment."

Pollution is due to the addition of faul constituents of water, air, Land which adversely effect the natural quality of the environment.

The largest pollution is caused due to population In the year 12,000 BC, the population was estimated to be 10 millions. By AD 1 human population grew to 300 millions. The average time required for doubling was about 2000 years from 1850 to 1950 the population got doubled again, 1171 to 2500 millions. The population may double again in less than 35 years or so the rate of population growth in India is also very high annually about 60 million people are being added. Obviously the increasing rate of pollution is also going on high.

Among all types of pollution, water pollution is the major source of environment degradation. Water is an indispensable natural resource on this earth on which all life depends. About 97% of the earth's surface is covered by water and most of the animals and plants have 60-65% water in their body.

Water is one of the principal life giving elements and its purity is directly related with the sound, human life, Industrialization and wide range of human activities have demanded for good quality of water while its pollution is increasing day by day. Infact water is a pre-condition of life. On the basis of the existing circumstances, it is quessed that in near future, good quality water, on account of the ever growing population and industrialization, will become a scarce commodity and as such, normal living of humanity will become very difficult. In view of this, a suitable and viable technology for purifying water has become essential.

Water is an Inexhaustible gift of nature. India is rich in surface water resources. There is a vast network of rivers and alluvial basins. However, condition vary from region to region. while some are drought affected, Others are frequently flooded with the rapid increase in the population. The demand of water for irrigation, human consumption and industrial use has increased considerably there by causing depletion of water resources. In context to the Indian subcontinent an extensive repository of literature is available which deals with composition of natural and polluted waters (Trivedy 1988, Sinha 1987).

Streams, rivers, lakes, well and tubewells are our natural sources of fresh water. To keep the life going and keep up the pace of progress, conservation of these water resources is of paramount importance. The types and sources of water contamination include "Point" sources of pollution which usually refers to waste being discharges from a pipe, and "non-point" sources which means all other sources

such as storm water, run off, irrigation (Which carries fertilizers and pesticides in to ground water), leaks from storage tanks and leach out from disposal sites. The last ten years have witnessed the publication of numerous articles reporting on the precarious nature of the Himalayan aquatic environment and the increasing stress upon its components (Rawat 1988, Kumar & Singh 1989).

It is estimated that hydrosphere contains 1500 million km^3 of water and 95% of it comes from sea. Another 4% is available in the form of show in mountains and cold regions. Only 1% percent of the water of hydrosphere is available for human needs. This one percent water is available from beneath the earth surface, Rivers, Lakes, atmosphere and biological system. Access of safe drinking water remains an urgent need as only 72% of the population in the urban area receives organized pipe water supply and the rest has to depend on surface or ground water which is untreated (Statistical Abstract of India 1942). In rural areas, the situation is the worst.

India being a developing country is rapidly marching towards Industrialization. A number of Industries are established but without concern to ecology or environment.

Ambast (1983) has expressed that "The presence of too much of undesirable foreign substance in the water from external environment adversely influences the quality of water making it unfit for drinking, washing, irrigation and fisheries etc."

There are many sources of water pollution in India. Most of these wastes are discharged untreated into the water courses. Contrary to the common belief, it has been estimated that the community wastes, " Account for four times as much waste water as industrial effluents." Industrial discharges and sewage are the two major sources of water pollution. The water is polluted by these sources in two ways : (i)

Burning of fuel in Industries releases gases such as CO_2, CO, SO_2, Cl and Fe etc. In the atmosphere when these substances mingles in the atmosphere and fall down on the earth pollutes the water resources (ii) Industries and domestic activities require large quantities of water and after using it let out as effluent and such effluents contain acids, alkalies toxins, inorganic and organic compounds and other kinds of dissolved and suspended solids (Azad, 1985).

When the water resources receive these effluents through channels, Erosion of land also adds to pollution of water bodies. The pollution causes or hazardous in the biological and physicochemical properties of water.

The water pollution biology has been attracting notice of the workers for the last hudred years. The growth of water pollution biology was un even and slow until about 1970 but during 28 years there has been greatest growth in our knowledge of polluted water due to increased scientific interest and financial resources. Some Indian states i.e. Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal are the main beneficiary of Ganga, Yamuna, Krishna, Betwa, Ken, Mandakini, Tons, Banas (Rajasthan) and in return they pollute them by discharging untreated effluent from tanneries, distilleries, Sugar factories, paper mills and house hold activties.

To this added the burden of other human activities like bathing, washing faecal matters immersion of dead bodies etc. According to a rough estimation 50% human diseases in India are water borne. Therefore, reducing the population of disease causing microbes appear to be the only appropriate step to minimize the dangers of water-borne diseases.

India is the seventh largest and the second most populour country in the world. The longest riverine length that is the most polluted in terms of Bio-chemical

oxygen demand (BOD) load in the river waters. It is followed by Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Orissa and Gujrat who have more than 6 mg/l BOD levels.

The more developed countries (MDC's) have only 22% of world's population, but they use 88% of its natural resources, 73% of its energy and command 85% of its income. In turn, they contribute a very big proportion to its pollution. These countries include U.S.A., Canada, Japan, The CIS, Australia, Newzealand and Western European countries. The less developed (LDC's), on the other hand, have very low or moderate industrial growth have 78% of the world's population and use about 12% of natural resources and 27% of energy. Their income is merely 15% of global income. The gap between the two is increasing with time due to sharp increase in population in the LDC's. The rich have grown richer while the poor have stayed poor or gone even poorer.

The Central Pollution Control Board's 10 year data shows that 14% of the entire riverine length in the country (6,086 Km.) is severely polluted with BOD level of more than 6 mg a litre 19% of rivers are moderately polluted with BOD level between 3.6 mg/l while 67% of rivers (30,242Km.) are relatively clean. About 1,35,000 polluting industires in India generate about 13,0 million litres a day of waste water of which only 60% generated from large and medium industries is treated, distilleries generate the largest amount of pollutant load followed by the textile industry, Engineering, Pulp and paper, say a study of the Central Pollution Control Board.

Water Scarcity is a harsh reality, not a remote danger in India. The increase in the demand of water in the foreseable future, Possesa serious problem. Human population is consuming more quantity of water for its drinking and household

purposes. It is surprising that the total water requirement under this head (5,121661 M.) is minute when compared to the agricultural and industrial requirement.

Except in monsoon drinking water problem is very common in most of the districts. The normal sources of water are surface and sub-surface. To over come the existing drinking water problem these two sources should be put under effective management. At present, number of wells are growing numerously day by day. If this process is continued without considering the recharge pattern, in the near future several problems may arise as the water strata will godown.

Agriculture, as the single largest user of fresh water on a global basis and as a major cause of degradation of surface and ground water resources through erosion and chemical runoff, has cause to be concerned about the global implications of water quality. The associated agrofood. processing industry is also a singnificant source of organic pollution in most countries. Aquaculture is now recognised as a major problem in fresh water. The term "Pesticide" is a composite term that includes all chemicals that are used to kill or control pests. In agriculture, this includes herbicides (weeds), insecticides (Insects), fungicides (Fungi), Nematocides (nematodes), and rodenticides (vertebrate poisons). UNEP (1993) linked the effects of pesticides to "the level of oncological (Cancer), Pulmonary and heamatological morbidity, as well as on in born deformities and immune system deficiencies. Human health effects are caused by skin contact: handling of pesticide products, Inhalation: breathing of dust or spray, Ingestion: pesticides consumed as a contamination in food or in water.

The Principal environmental and pablic health dimensions of the global fresh water quality problem are high lighted as five million people, die analysis from water born diseases. Eco system distruction and loss of biodiversity. Contamination

of marine ecosystems from Land based activities because pollution can no longer be remedied by dilution in many countries, fresh water quality will become the principal limitation for sustainable development in these countries early in the next century.

Rivers have got very important place in Indian culture and tradition. They are the life line of majority of population in cities, towns, and villages and most of these are considered sacred. During festivals people take holy dip in rivers. Every river stretch has distinct water use like bathing, drinking, municipal supply, navigation, irrigation and fishing. Simultaneously. It is also used as a receptacle for discharge of Industrial effluent, muncipal sewage and dumping of solid wastes. The water (Prevention and control of pollution) Act, 1974 is aimed to support the water quality of various designated best-uses of water bodies. The water quality Atlas of the Indian river system was prepared on the basis of five major uses of river water such as; :

(a) Drinking water source without conventional treatment but after disinfection; (b) outdoor bathing organized; (c) Drinking water source with conventional treatment followed by disinfection; (d) Propagation of wild life, fisheries; (e) Irrigation, Industrial cooling, controlled waste disposal.

A river during its course of flow has definite basin area. The basin area is the geographical extent in the catchment of river from where precipitator water joins the river. It includes tributaries and the drains. Indian rivers on the basis of their basin have been divided into three categories as major medium, minor river depending upon basin area. Major rivers are those rivers which have basin area-20,000 Sq Km or more. The rivens having basin area between 2000 and 20000 Sq Km are grouped as medium rivers and rest rives are minor rivers. There are 13 major river basins and as a group, these basins cover 80% population and 85% of total river discharge.

Among the 45 medium river basins, four are International and eleven are interstate river basins. A total of 17 rivers having a combined basin area of 63,500 Sq. Km. joins, the Arabian Sea, while remaining 24 rivers having a combined basin area of 210596 Sq. Km. joins Bay of Bengal. The four rivers originate in India but across the national boundary, thus incorporate international river basin. Medium river basins occupy 8% of total basin area and about 119940 million cubic meter water flows through these.

There are fifty five minor river basins having a combined basin area of about 2 lakh Sq. Km. Most of these originate from Eastern and Western Ghats. The total area of minor basins is about 9% of total basin area of Indian rivers.

The main source of water is river viz. Ganga, Yamuna, Gomti, Ghanghara, Narmada, Ken Betwa, Paisuani and Mandakini etc. Ganga is a holy river in India and the river Yamuna is the largest tributary of river Ganga . Which is considered sacred as per Hindu Mythology among all the rivers.

The catchment of the Yamuna river system covers parts of the states of Uttar Pradesh, Himanchal Pradesh, Hariyana, Rajasthan, Madhya Pradesh and the entire state of Delhi. Each one of these major tributaries in turn have its own tributary system. Ken, Betwa, Tars, Giri and Chambal are tributaries of Yamuna which join to it at different places. Yamuna is highly polluted at Delhi, Mathura, Agra, Kalpi and Allahabad.

The Ganga Action plan (GAP) was formulated and Launched Primarily to arrest degradation of river water quality by a programme of interception, diversion and treatment of domestic sewage and prevention of toxin and industrial chemical wastes from identified grossly polluting industrial units stations entering in to the river.

The National River Action Plan has been conceived as larger plan to under take pollution abatement in all the polluted river stretches. Industrial units are being persuaded to adopt clean technologies, to install and operate the treatment plants. 17 categories of major polluting industries were identified and targets were fixed adopt pollution control measures.

Physico-chemical characteristics of water are the main factor for determining the quality and pollution status of water. A large part of the domestic sewage is the most important pollution source contributing pathogens, the main source of water born diseases along with depletion of oxygen in water bodies. This results in stagnation of sewage within the cities, which contaminate, the ground water by percolation through soil. As this water is only source for drinking purpose in many cities.Besides the sewage is breeding ground for mosquitoes.

According to the central pollution control board (2000), 90% of the water supplies in Indian towns and cities are polluted out of which only 1.6% gets treated. According to a new report titled " Water resources in the 21st century, challenges & Implications for action" by the Washington based International Food Policy Research Institute. (IFPRI), points out that only 8 out of 3119 towns in India, fully treat their sewage. Obviously a large number of untreated sewage cause water pollution which is great hazard a large population of India.

Mandakini is important river which from the Panna hills and flows east as long as near village kathkone in Nagod Tehsil. It is joined by the Amrah river and from this point of Junction, it bends towards the south, making the boundary of Nagod and Raghuraj Nagar tehsils and further it meets the tons river a few miles away to the south east of Satna city.

River Mandakini; populary called "*Maa Ganga*" is life line of millions of people. It is closely related with our history, culture, tradition, religion health, Philosphy and well being of large population. It is in Vindhyan range which is Planteau.

Rivers are symbol of prosperity, culture, heritage, civilization and philosophy. Having in view the above facts the river Mandakini of religious place Chitrakoot is choosen for the present study. This river emerges from Kelhaura hills which are about 20 km. west to Majgawan town- a block and tahsil of district Satna (M.P.). It joins river Paisuni at Ramghat in U.P.. This Sangam is Raghav prayag which resembles with Prayag Sangam. So it is very important holy place. Further Paisuni flows on wards and joins river Yamuna at village Kankota near Rajapur town in Karvi district (U.P.) which is the birth place of Saint Tulsidas.

Satna district lies on Vindhya Plateau, which has an average altitude of 1000' to 11000'. The southern portion of Nagod Tehsil below 24°30' north Latitude is a hilly place consisting of a tangled mass of low hills, and enclosing considerable stretches of Level ground. The height of the plateau enclosed by these hills is from 1700' to 1800' generally but occasionally, some of the hills in the south of the Tehsil rise to more than 800 feet in height above the plateau. The general slope of the tehsil is towards the east, inclined towards the north in the centre of the tehsil.

The total catchment area of the Mandakini & Paisuni rivers is 1675 Sq. Km. out of which 385 Sq. Km. lies in Madhya Pradesh which is covered by the river Mandakini. Its Latitude 24° 52' N. and longitude 80°41' E. The river flows in a South to North direction, whereas in last reaches in west to east trend.

The river Mandakini has two major tributaries and many more small nalas draining parts of the catchment area. The first tributary, river Tiraha originates at

latitude 24° 58' N. and Longitude 80°40' E and flows parallel to Mandakini for about 20 kms and falls in to river Mandakini at about 10 kms upstream of Sati Anusuiya. The second tributary, Jhuri Nadi, originates near village Kolhuwa from Padwania protected forest in U.P. at latitude 25^0 4 N and Longitude 80^0 45' E. and enters in U.P. at latitude 25^0 4 N. and longitude 80^0 45' E. and further it enters into M.P. and travels about 15 kms and then falls into river Mandakini about 1 km downstream of Sati Anusuiya.

The area has great historical, mythological and religious significance. It is believed to have shelter of Lord Ram for a long period during his exile. This fact imparts great importance and holiness not only to Chitrakoot but also to river Mandakini, which would have been the prime water source for Lord Ram. Hence river is worshipped. Although having a rather small catchment area and water flow, this has gained considerable significance in the Hindu ethics. On the occassion of Amavasya, Deepawali and other auspicious days, lacs of people take dip in the river and offer their prayer to it. It's quality and purity thus gains importance much larger than the river size.

The land areas under different uses of Madhya Pradesh part of basin areas. It is that 23.4% of the total area is under cultivation and 36% of the total area is under forest cover. Western side of the bank has many Ghats and temples. Whereas on the Estern side are dense forest where many wild animals are found. Due to shallow nature of the river it is weed infested. In shallow and stagnant reaches, dense weed-growths were observed giving an unpleasant odour. Obiviously profuse growth of weeds reduce aesthetic look also the stink emanating from decomposition of dead part of weeds, drives away people the catchment area of river Mandakini is steep, rocking undulated hills with vegetation and big sheet rocks. Whereas at Sati Ansuiya is dense forest.

Many Arjun trees are found growing on the rocks on the river bank which are of great medicinal in importance as they are used for heart and blood prasure Patients. Besides the river water is also very beneficial for drinking purpose.

The river is also used for public water supply by two pumping stations which are in M.P., One at Pindra which supplies water 0.31 MLD. It is located nearly 15 Km. away from Sati Anusuiya and 1 Km. away from Sirsavan which is for Chitrakoot water supply. Its capacity is 0.55 MLD.

Pilgrim activities also become significant source of water pollution, which may upset the natural purification and rhythm of the river due to the sudden load dumped into the river. During special occassion such as Deepawali, Somvati Amavashya and other major auspicious days, such loads may become enormous due to 5-6 Lacs or even more pilgrims congregating in this area.

In the connected residencial and reverential areas such as Sati Anusuiya, Janki Kund and Ramghat, Waste-water often enters openly in to Mandakini creat nuisance and also apprehension of health problems and the city nala entering at Ramghat is essentially an 'open ditch' of domestic sewage and human excreta. The floating algal scum, mostly during summer months, spreads a bad stink all along the reach.

The management of this river to remove pollution is quite essential for which scientific measures are suggested to irricate weed infestation and algae in Ghats.

further by checking solid wastes, discharges, falcal matters Ammonical nitrogenous substances by leaching from agricultural lands etc. So the river water might be suitable for drinking to promote human health and also beneficial for aquatic biota. Besides by solving the problems of piligrims.

Thus the entire ecology of the river along with human welfare might be properly maintained. Having in view the entire ecology of this river 4 sampling stations were choosen which may reveal its whole nature as regards Physico-Chemical and biological Characteristics. River Mandakini flows south to north and passes majorly through village and Agricultural areas and also through many religious spots such as Sati Anusuiya, Sphatikshilla, Janki-Kund, Pramod-Van, Raghav-Prayag all of which are centre of pilgrimage.

1. Station-I (Sati Anusuiya)

It is at the origin of river Mandakini which is from mountain Mahendragiri. This is known as Sankat Mochan Shila. The garden is known as Swami Paramhans garden. Adjoining to it is Ansuiya Ashram which is 18 kilometre south from Ramghat. A number of streams flow continuously from here which meet at a 'Kund'. The villages in an area of 5-6 km. are Rukma, Dadri Madayian are situated in east side where as Tikaria Markundi are situated in the south east. The river is very narrow at this station.

2. Station-II (Sphatic Shila)

Sfatic Shila is situated at a distance of 6 km. from Ramghat here, the width of the river is about 100 metres. It is said that Lord Rama and Sita took rest on this Shila while going to ashram of Atri Muni. Once Indra's son Jayant took form of a crow and bitted Sita by his beak.

3. Station-III (Janki Kund)

Janki Kund is situated at distance of 3 km. from Ramghat. It is located just a head Arogya Dham. A number of Arjun trees are at this station which have of medicinal value. So the chemical composition of his water is quite benefical for human health.

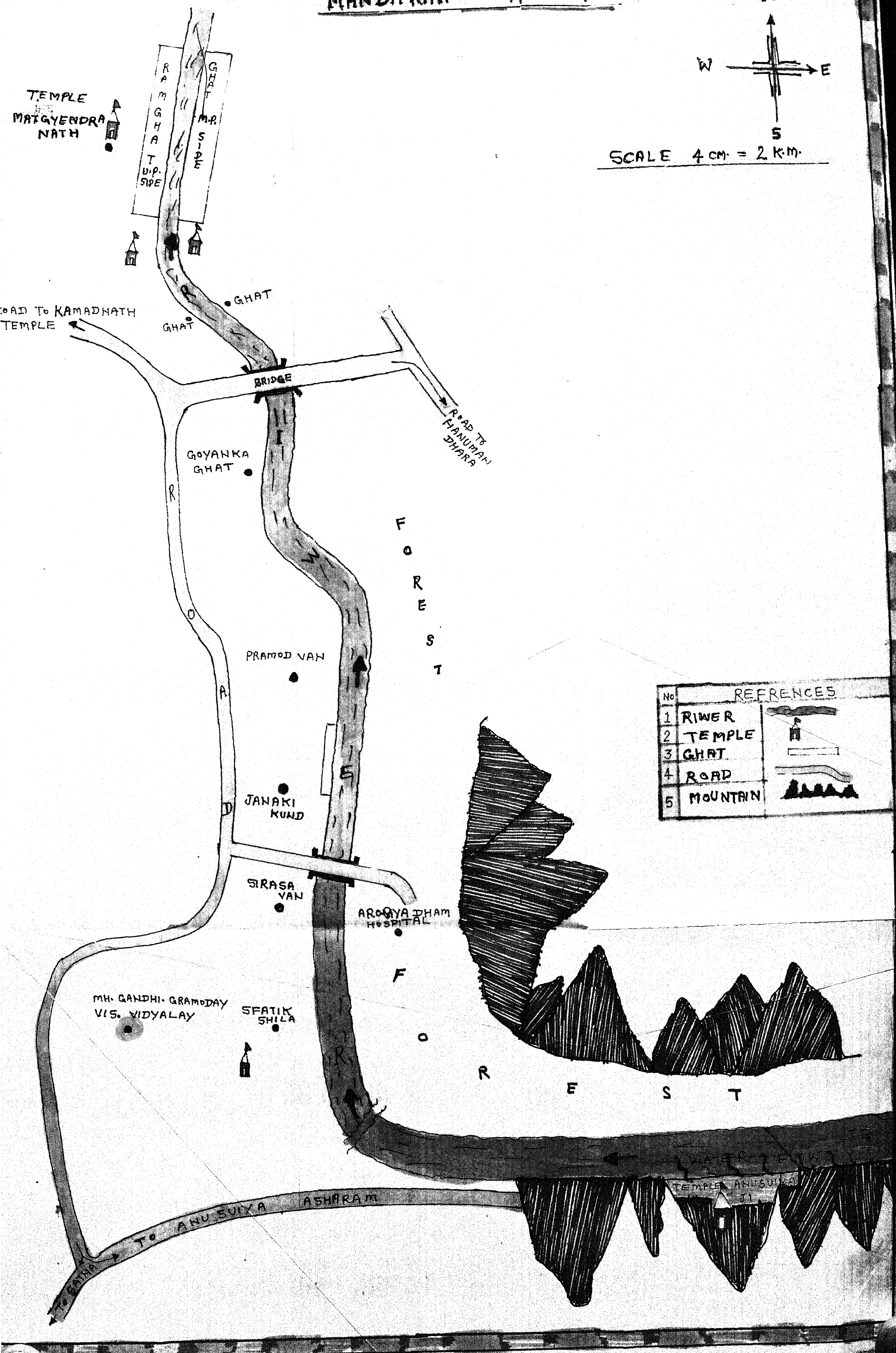
4. Station-IV (Raghav Prayag)

Raghav Prayag is situated at a distance of 18 km. from Anusuiya Ashram. Here 3 holy rivers confluence viz. Gaytri, Paisuini and Mandakini. So, it is known as Raghav Prayag Sangam.

Beyond this the river is named as Paisuini because some times. Whitish Colour appears like milk dhara. This river flows further south to north and confluences with river Yamuna at Kankota near Rajapur in Distt. Karvi.

The entire river stretch of Mandakini is 385 Sq.km. which is undulating and hilly with rocky basin.

INDEX MAP OF MANDAKINI - RIWER



REVIEW OF LITERATURE

HISTORICAL RE"SUME"

Rivers have been studied for many years with inputs from many disciplines of sciences and humanities. Engineers, Hydrologists, Geographers, Economicsts, Biologists, Chemists, Geologists and social scieentists have produced literature on regional Hydrographical, chemical and Historical aspects Living stone, (1963; whitton 1975; Moss, 1988; Barnes and Mann, 1980). UNESCO (1979) and UN (1981) also produced data on 29 Large rivers of the world.

The water quality is assessed by its Physico-chemical and biological analysis. The riddle of these Environmental protection hold a place of prominence among the global problems. More work on Physico-chemical and biological factors has been done in foreign countries but our country legs behind in this field. So, the work in this regard is stills to be done besides as present the Indian rivers are affected with pollution for which their water quality analysis to make the pollutents and their measures are studied scientifically.

The contribution of the workers in this field are mentioned as Under:-

Sedgwick (1989) and forel et. al. (1882) are few pioneers in this field. Kojoid (1903) studied the pollution and purification in the Illionis river system. Forbes et. al. (1913-1919) studied the biology of upper Illinois river. Shelford (1917) and Ellis (1913) classified river water into zones of pollution and clear water. Allen (1920) studied the quantitative and statistical study of the plankton of Sanjoaquin river and its tributaries in and near stockton. While Griffith (1923) studied the Phytoplankton of fresh water in relation to occurrence and composition stockton. Butcher et. al. (1930) observed variations in the composition of river water. Atkin (1932-33) studied the chemistry of sea water in relation to the productivity of the

sea Theriault, et. al. (1932) analyzed D.O. in the presence of organic matter, hypochloride and sulphite wastes. Howard (1933) determined total dissolved solids in the water analysis. Collins, et. al. (1933) analyzed chloride and sulfate in rain water. Cooper, (1934) determined phosphate and nitrogen in plankton. Zernoy, (1934) describe General Marine and fresh water.

Juday et. al. (1935) reported CO_2, and pH of lake water of north-eastern wisconsin, Sewell (1935), studied the tropical and subtropical waters in certain areas. Majeed (1935) studied the fresh water algee of Punjab. Skuortzov (1935) studied the Diatoms from Calcutta India. Biswas (1936) observed the common diatoms of the Loktak lake, Manipur. Eillis, (1937) discribed detection and measurement of stream pollution. Eillis (1937) pointed out the breathing distress to direct damage caused by organic matter. Hutchinson (1937) Limnologic studied in India. Evans (1938) studied Transportation of sediments on fresh-water. Ohle (1938) studied the control of Liming in ponds for p^H and Alkalinity determination. Jones (1937), observed breeding habits and development of certain brackish water fishes of Adyar.

Chandler (1940-1944) observed Plankton and certain Physico-chemical parameters on light entrance and its relation to turbidity, and in relationship of the Phyto-plankton to the limnological and climatic factors respectively of western lake of the Bass islands.

Berg, (1943) described Physiographical studies of the river susaa-welch (1948) wrote Limnological methods, London. Adyar is the first river in India which was explored Hydrobio-Logically by chacko and Ganapati (1949). Roy, (1949) described some potamological aspect of the river Hooghly in relation to Calcutta.

Ganapati et. al. (1950) reported the pollutional effect of the effluents of metter chemicals and Industrial corporation Ltd. on the fishes of river cauvery. Diehl et. al. (1950) studied the water hardness to a measure capacity of water to precipitate soap. Berner (1951) studied Limnology of the Lower Missouri River.

The effect of Godavari had been shown by Ganapati and Chaoko (1951). Welch (1952) wrote Limnology Mc. Graw Hill Book company New York U.S.A. Chacko, and Ganapati, (1952) did Hydrobiological survey of Suruli river in the highways Madurai district India to determined its suitability for the introduction of the Rainbow trout. John (1952) studied the effect of water pollution and its effect on Public health.

Sawyer (1953) observed that the ammonic is naturally present in surface and waste water. Patrik (1953) described the biological phases of stream pollution Hildbrand (1953) studied that the concentration of sulphate in the most fresh waters is Low. Wadia (1953) viewed that the absence of any large strange facilities natural lakes or man-made reservoirs in the upstream areas results in rapid transmission of flood waters. Matsudaira and Kato (1953) observed the impurities in rain water in oska and kobe cities.

Anderson, (1955) noted on the Phytoplankton and zooplankton relationship in two lakes in Washington. Penna K (1955) described the comparative limnological study of eight lakes of colorado mountain. Ray, (1955) studied ecology of the river Hooghly at Palta.

Doraj Rajan and Pankajam (1956) did significant work on the hydrology and plankton of Bhawani sagar reservoir in Madras state.

Pirozhnikov, and Shulga (1957) studied the basic characteristics of the zooplankton of the lower river Lina Russian.

Philipose, (1959) worked on fresh water phytoplankton of Inland fesheries. Chakrabarty et. al. (1959) made a qualitative study of Plankton and Physico-chemical conditions of river Yamuma at Allahabad. Ray and Singh, (1959) described a quantitative study of the plankton and the physico-chemical conditions of the River Yamuna at Allahabad. Todd, (1959) studied Ground water Hydrology. Bond,et. al. (1959) studied toxicity of various herbicial meterials to fishes in biological problems in water pollution. Das, and Srivastava, (1959) reported fresh water plankton their qualitative composition and seasonal fluctiation in plankton components. Clemens, etal (1959), observed to the effects lethal of several commercial chemicals to fingelings of catfish.

Hynes, (1960) Analysed the biology of polluted water liver pond. Alabaster, (1960) described adverse effects of toxicity of weed killers, icides and fungicides on trout. Holland, et. al. (1960) analysed Toxic effects of organic and in organic pollutants on young Salmon and trout.

Rao (1961) carried out a systematic hydrogeological study in parts of Hoshangabad and Narsinghpur district of M.P.. Hazlwood and Parker (1961) studied the population dynamics of the fresh water zooplankton. Scmid and Mann (1961) carried out a action of a detergent on the gills of the trout.

Hynes and Robes (1962) analysed the biological effects of synthetic detergents in the river Lee, Hertfordshire. Gandhi, (1962) wrote notes on the diatomaceal of Ahemadabad International Water Supply Association (1962) presented reports by Technical Commission on pollution of surface water.

The first study on the plankton of the Tungbhadra reservoir was made by Govind (1963). Observations on the death of fish due to cold in the river Gandak was done by Jhingran et. al. in (1964). Arora et. al. (1965) analysed biological characteristics of water quality at Nagpur. Tarzwell, (1965) studied Biological Problem in water pollution.

Qasim and George (1966) stated the Bajora river at Bareilly and Kali river near Meerut and Ganga river at Kanpur are contaminated with highly oxidisable organic components of Industrial waste which causes harmful effects. Gopala Krishnan et. al. (1966) drew attraction that the effluents of fertilizers corporation of India in the river Damodar and of Sindri fertilizers showing its influence on the fish mortality of Panchat reservior at Siwan distt. in North Bihar. X-ray (1966) observed that the wastes of about hundred tanneries, twenty textiles, woolen, cotton and jute mills with a number of chemicals and Pharmaceuticals together with the foul millions peoples wastes is also being added at Kanpur which make water toxic. Sitaramaiah (1966) studied the ecology of a fresh water pond community. Michael (1966) studied and dirurnal variations of Physico-chemical factors and diurnal variations of zooplankton in the surface layers of three fresh water fish ponds. Sreenivasan (1966) described Limnology of tropical impoundments and fish production in stanley Reservoir.

Hutchinson (1967) published a treatise on Limnology. Imevbore (1967) studied the hydrology and plankton of Eleiyele, reservoir, Lbandon. Jafer (1967) worked on ecology of Algae in certain fish ponds of Hyderabad. Bulusa et. al. (1967) did certain observations on self purification of Khan river and Kshipra river.

Downing and Edwards (1968) studied the effluent standards and the assessment of the effects of pollution on rivers. Brydges and Briggs (1968) analysed ammonia concentration in natural waters. Malhotra et. al. (1968) presented papers on production of the quality of fish seed for fish culture at Barrackpore.

Banergee (1969) discribed the east west river system as tributary of Mahanadi which faces severe pollution problems due to the discharge of many paper mills. A distinct relationship between plankton periodicity and rain fall was observed by Lind (1969)

Verma and Shukla (1970) studied the biological aspects and physico-chemical characteristics of Kamla Nehru tank at Muzaffar nagar (U.P.). Nicola and Borgeson (1970) studied limmoligy & productivity of these cold reservirs in California. Brown et. al. (1970) gave method for collection and analysis of water samples for dissolved minerals and gases.

Forged (1971) observed the fresh water diatoms in Srilanka. Remson, (1971) described numerical methods in Sub-surface Hydrology. U.S. Public Health Services (1972) reported drinking water standards Shastri, et. al. (1972) discribed water pollution Problem in M.P. Hem, (1973) gave study and interpretation of the chemical characteristics of natural waters. Schroeder, (1973) studied the Relation of trace metals to human health effects. in chemical analysis of the environment and other modern techniques.

Jhingran (1974) described the Kali river and its effluents of petroleum industry where D.D.T. and atomic energy are discharged wastes. Arora and Chattopadhya (1974) did study on the effluent disposal of superphosphate fertilizer

factory. Janakiram (1974) worked on systematic and on some aspects of ecology of fresh water of Guntur District (Andhra Pradesh India).

Rao (1975) described India's water wealth. Whitton, (1975) did a study of river ecology, University of California press Berkeley. Higgins and Burns (1975) studied the chemistry and Microbiology of pollution in New York.

Agrawal et. al. (1976) studied Physico-chemical characteristics of the Gangas at Varanasi. Venkateswaralu (1976) studied the Taxonomy and Ecology of Algae in river Massi Hyderabad. Sahai and Sinha (1976) observed the productivity of submerged macrophytes in polluted and non- polluted regions of the Eutrophic lake at Ramgarh.

Erikson (1977) reported water chemistry and water quality. Lopez and Lee, (1977) studied Environmental chemistry of Cooper in Torch lake, Michigan in water, air and soil pollution. Chiba and Takahashi (1977) studied heavy metal pollution. Erikson (1977) reported water chemistry and water quality. Vass, et. al. (1977) investigated hydrobiological conditions of river Jhelum.

Bates (1978) reported that the pH is used in alkalinity CO_2 measurement and many other acid base equilibrium Hauntage, (1978) studied the pollution of Naha river in Germony. Nemerow (1978) described Industrial water pollution, Addision wesley Publishing company. Rai (1978) did Ecological studies of algal communities of the Gangas river at varanasi India.

Unesco (1979) reported discharge of selected rivers of the world, UNESCO, Paris. Getz. et. al. (1979) gave transport and distribution in a water shed ecosystem. Bilgrami and Datta (1979) did limnological survey and impact of human activities

on the river Ganges, Barauni to Farakka. Govindan and Sunderesen (1979) studied the highly polluted nature of scum oil organisms in Adyar river of Madras.

Pandey et. al. (1980) studied the metallic contents in water and sediment of lake Nainital. Mayer and Glossa (1980) studied the silka and phosphate ina turbid river. Pandey et. al. (1980) described role of microflora in the assessment of pollution level of river Gangas at Kanpur. Palmar (1980) studied algae and water pollution.

Linden et. al. (1981) studied effects of muncipal waste water effluent irrigation scheduling on nitrogen rennovation. Reddy (1981) wrote on diel variation of certain physico chemical parameters of water in selected aquatic systems. Chatterji et. al. (1981) studied the ecology of river Kali in Aligarh (India).

Venkateswarlu and Kumar (1982) analysed chemical and biological assessment of pollution in the river Moosi Hyderabad (A.P.). Upadhayay et. al. (1982) studied the physico-chemical conditions of the river of Kathmandu valley and reported pH and conductivity.

Singh (1983) investigated the hydrobiology of a pond in shahjahan garden, Agra. Truesdale and wellings (1983) observed organisation of sewage and industrial sludge utilization. Bhargava (1983) investigated the quality of river Jamuna and concluded that the water of the river is good enough to human consumption only after suitable treatment.

Azad and Hardan (1984) described the Industrial waste water management. Trivedi and Goel (1984) Presented the current Pollution Researches in India. Tripathi and Sikandar (1984) worked on the Physico-chemical characteristics of Ganga water

at Varansi. Chattopadhyay et. al. (1984) worked on a short term study on the pollution status of river Ganga in Kanpur region.

Bilgrami and Datta (1985) studied the Ecology of the river Ganges at Patna Parakka. NEERI (1985) worked on wastewater treatment. Singh, and Bhowmick (1985) studied the effect of sewage sludge of low and high metal content for grain production.

Venkateswarlu (1986) did ecological studies on the rivers of Andhra Pradesh with special reference to water quality and Pollution. Bilgrami et. al. (1986) studied the impact abiotic factors on bacterial population of river Ganga.

Bird (1987) studied the effects of hydrobiological factors on the concentrations of copper, iron, mangnese and zinc, in river Tawa in South Wal which cause errosion and weathering. Singh (1987) studied the Limnology of the circuit house pond Agra.

Dutta et. al. (1988) studied Hydrobiological profile of Hooghly sector (Bally to Bandal) of River Ganga Sinha (1988) worked on effect of waste disposal on water quality of river Damodar in Bihar. Gupta et. al. (1988) studied the level of pollution of Ganga river.

Srivastava (1989) did Limnological studies of the aquatic eco-system in Allahabad region with special reference to the effect of human activities on its biotic potential. Kulshrestha et. al. (1989) a studied on pollution in river Kshipra . Ambasht and Srivastava (1989) worked on energy dynamics of macrophytes at up and downstreams of river Ganga at Varanasi.

Bharti et. al. (1990) studied the effect of Industrial effluents on River Kali around Dandeli at Karnataka. Taylor et. al. (1990) analysed the quantitive analysis of dissolved trace metals on the Mississippi river at United States. Balmforth (1990) worked on the pollution aspects of storm sewage over flows, Water and Environmental management. Mittal et. al. (1990) studied the Physico-chemical characteristics of water Kartwan river, Agra. Singh et. al. (1990) did pollution studies on river subernrekha around Industrial belt of anchi (Bihar).

Tripathi et. al. (1991) worked on Physico-chemical characteristics of city sewage discharged in to river Ganga at Varanasi. Dutta and Singh (1991) worked on Physics chemical properties of river Ganga at Kahalg on Bihar. Kumar et. al. (1991) studied Implication of thermal discharges into the sea. Sarwar et. al. (1991) reported physico-chemical parameter of a fresh water pond of Shri Nagar in which temperature varied from 4^0C to 24^0C pH was between 7.0 and 8.2 and electrical conduct between 297 and 689 us/cm. Singh et. al. (1991) investigated Physico-chemical factors and Phyto phankton of Pawapuri pond and observed that pH, dissolved oxygen, Alkalinity, chloride and phosphate depicited erratic seasonal fluctuation imparting profound impact on the Phyto plankton.

Jhingran (1992) worked on the fish and fisheres of India. Verma et. al. (1992) studied impact of Industrial effluents on aquatic biota of river Subernarekha at Ghat sila at three different station Gautam (1992) studied industrial effluents and aquatic pollution. Hora (1992) reported pollution of stream and conservation of fisheries Darfealing and Kubawara (1992) reported Association between benethic flora and diel changes in dissolved arsnic. Blindow (1992) worked on Long and short-term dynamics of submerged macrophytes in two shallow eutrophic lakes.

Ahmed (1993) reported correlation between Physico-chemical factor and zooplankton in Dholi tank, Bihar. Verma (1993) worked on Physico-chemical and Biological parameters of Betwa river at Mandideep. Pandeya et. al. (1993) have determined the manganese content of drinking water drawn from various sources in several parts of Rewa region (M.P.). Jameson (1993) did Ecological studies of some polluted rivers of Gujrat. Mishra (1993) studied water quality, Primary Productivity of Macrophytes and Heavy metal toxicity in aquatic Ecosystem.

Asthana (1994) did Physico-chemical studies of Gomti river water with reference to heavy metal Pollutional Jaunpur. Ramana et. al. (1994) studied the water quality of river Tungabhadra. Gupta et. al. (1994) studied the siasonal variations of selected limnologyical parameters in Amarchand reservoir Rajasthan. Kaushik and sharma (1994) worked on, Physico-chemical characteristics and zooplankton population of a perennial tank, Matsya Sarovar, Gwalior. Katariya (1994) described an evolution of water quality of Kaliasot river, India. Ramana et. al. (1994) worked on preliminary study on water quality of river Tungabhadra at Karnool town;

Strikanth et. al. (1995) worked on Physico-chemical Parameters of river Pennar, Andhara Pradesh. Verma et. al. (1995) studied Physico-chemical characteristics of fresh water pond at Laximisagar. Trivedi (1995) worked on International Encyclopedia of Ecology and Environment. Singh (1995) studied Physico-chemical and biological analysis of river Ganga in Kanpur District. Jason (1995) did monitoring and management of stream bank erosion and natural vegatation on the lower Gordon river Tasmania.

Shukla (1996) compared the Physico-chemical characteristics of water

quality of river Betwa, Kolar dam and upper lake of Bhopal. Antonie et. al. (1996) studied the enviournmental and hydrological characteristics of the river Taff.

Upadhyay (1997) studied Physico-chemical analysis of Kaliasote dam water. Kaushik (1997) worked on Occurance of heavy metals in Lentic water of Gwalior region. Dwivedi (1997) studied Heavy metals in the Ganga water at Varanasi.

Jameel (1998) did Physico-Chemical studies in Uyya Kondon channel water of river Cauvery. Anjali (1998) studied zoo-Phytoplankton in river Yamuna at Kitham. Khurshide et. al. (1998) worked on the effects of waste disposal on water quality in parts of cochin. Doctor et. al. (1998) studied the Physico-chemical and microbial analysis of dye contaminated river water.

Singh (1999) studied Physico-chemical characteristics of water in the upper stretches of Damodar River. Pande et. al. (1999) analysed the distribution of organic matter and toxic metals in the sediments of Ramganga river at Muradabad. Xavier et. al. (1999) studied hydrochemical characteristics of chaliyar river. Sharma et. al. (1999) assessed the water quality of river Yamuna at Agra.

Singh et al. (2000) studied the Physico-chemical characteristics of a major water body of Imphal District. Mohd et. al. (2000) worked on Evaluation of water Quality in Trichnapalli. Singh (2000) studied seasonal variation of zooplankton in tropical lake.

Gyannath, et. al. (2001) Assessment of Environment Parameters and Ground water Quality. Mishra and Tripathi (2001) reported impact on Physico-chemical characteristics of Ganga water due to city sewage discharge. Nath (2001) studied water and soil characteristics of the Narmada estuary. Ray and Kumar (2001) studied

water Quality of the Rivers of Ranchi District.

Saravanan et. al. (2002) worked on the fresh water fishes as indicators of kaveri River Pollntion. Rakhee et. al. (2002) studied the effect of Physico-chemical factors on Phytoplankton in lotic enviournment of Alaknanda River Garhwal.

Mishra et. al. (2003) worked on the Seasonal variation in Physico-Chemical characteristics of Ganga water influnced by sewage discharge. Islam and Kumar (2003) studied diversity index and pollution status of an aquatic ecosystem at Bodh-Gaya (Bihar).

Dubey et. al. (2004) investigeted ecological restoration and sustainable developmental problems and their perspectives. Habib (2004) did Hydrobiological studies on river Nakatia at Bareilly.

Agarwal (2005) studied Environmental loss in India, Challenges for enforcement. Kohli et. al. (2005) worked on the need to establish long term ecological research network in India. Alegri et. al. (2005) worked out the performance of in dicators for water supply. Imura et. al. (2005) reported the Japan's enviournmental policy.

Hughes et. al. (2006) studied linkages among landscape and associated physico-chemical and biological characteristics of river.

On the basis of the given contributions as regards various aspects of water pollution etc. in rivers the present work will be carried out as detailed study of the rivers Mandakini having in view its aims and objectives because previous investigations do not provide sufficient informations on the various aspects of the said rivers as etc. Physico-Chemical biological characteristics and production structure of the river Mandakini.

METHODOLOGY

METHODOLOGY

Since 1970 water pollution has become a serious increas which is rapidly increasing. As this pollution bring about undesirable changes in Physico-Chemical and biological characteristics of water, and harmfull affects on human life. The health critically depends upon the availability and quality of drinking water.Besides it has great impact on aquatic biota. In this regard study the river Mandakini in Satna District of M.P. . I was performed for the period of two years (Jan. 2005 to Dec. 2006) So, for the assessment of water quality of this river. The Physico-chemical parameters, Viz. water Temperature, Turbidity, colour of water, p^H dissolved Oxygen, free, Carbondioxide, total alkalinity, total hardness, water samples were collected from four different stations every month and they were analysed for the above parameters along with its biological analysis.

For the estimation of all the said parameters the methods suggested by " American Public Health Association (1995) were followed. The detailed methods for each parameters under study are given as under:

Water Sampling

Water Samples for Physico-Chemical and biological analysis were collected from the four differents stations. For it sub-surface of water was taken by boat. The samples of water were collected in the Iodine treated polythyne bottles without much disturbance at the sampling stations. The samples were collected in the first week of every month from Jan. 2005 to Dec. 2006 in the early hours of the day with all the required precautions to avoid change in the chemical characteristics of water. These samples were collected from each experimental station for the estimation of Physico-chemical parameters dissolved oxygen and plankton study. Do bottles of 300ml. capacity were used to collect and fix dissolved oxygen.

Uddgam Sthal

Plankton (Phyto and zooplankton) were collected by filtering 25 litres of water through abothing silk net No-25 (65 um). The filtrate was preserved at the sampling station in 4% formation in plastic tubes.

The Physico-Chemical analysis of the water samples was done as per method of A.P.H.A. (1995) estimated in the laboratory with in the period of 4 to 6 hours. Besides some water samples were " Industrial Toxicology Research Centre", Lucknow. For the confermation of the test of the Parameters for under study.

Analysis Techniques

Meteorological data are recorded for the period of two years i.e. (2005-2006) from collectrate office at Nagpur and their means values were calculated.

To explore the entire-river Mandakini four sampling stations were choosen in such a way having in view different aspects of the river so that the entire study of this river might be worked out the selected sampling stations are as under.

Station-1 Sati Anusuya

It is located adjoing to the temples of Sati Anusuya their on the other side of the bank is dense forest with wild life animals. The river is quite right at this side a number of fishes also found their.

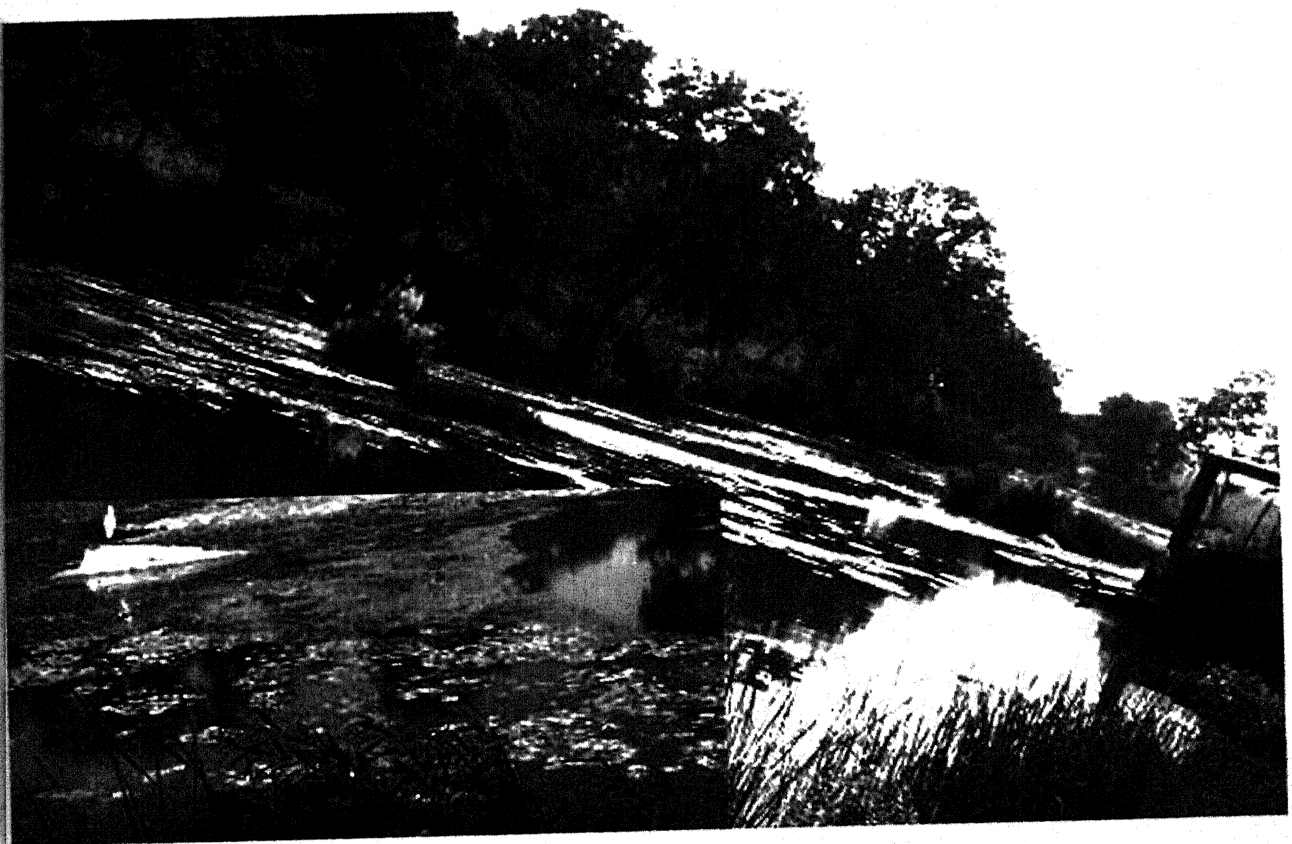
Station-2 Sphatic Shila

It is a holy place known for the foot printes of Lord Ram and is a visting place. This Shila is on the western bank were as the estern banks is less densed forest.

Station-3 Janki Kund

It is located to 2 Km. on words to sphatik Shila. It is the most Important

Sampling Station-II, Sphatik Shila



Sampling Station-II, Sphatik Shila

religious spot. A large number of people take dip their. On the wester bank a very large size of ghat. On the estern side a number large tree with the spatiality of Arjun tree. Some of which are in the river water. This are of great medision Importants.

Station-4 Raghav Prayag

It is at the confluence of Mandakini, Gaytri, Paisuini river, confluence and is known as Raghav Prayag Sangam obviously. It has it's important their on the both the side on the bank are large ghats. Which are used by peoples for taken dip in the river.

The intire river is narrow, but perrennial their are aquatic weeds mostely on the estern river basin.

Physical Parameters

Temperature

The temperature of water was recorded at the time of sapling byamurcury thermameter graduated upto accuracy of 0.5^0c. the measurementrange was from 0^0 to 50^0c.

Turbidity

Turbidity was recorded by a systronics Nephloturbidity meter and expressed as NTU.

Colour

The colour of water was observed by visual appearance only.

Water Current

Water current was measured by a mechanical current meter and expresed in curent cm/Sec.

ampling Station-III, Janki Kund (Sewage Discharge)

Chemical Parameters

Hydrogen-ion Concentration (p^H)

The p^H of the samples was measured with lobibond p^H comparator box at the sampling station besides it was also confirmed in the laboratory by p^H meter.

Procedure

In a clean glass tube of the lovibond comparator 10ml. of the water sample was taken and in to it 0.5 ml. indicator of the required p^H range was added. On stirring the indicator a colour developed, which was compared with the colour disc.

Total alkalinity (T.A.)

Total alkalinity was determined by titrimetric method, 50 ml. of the sample was taken in a conical flask, placed on a white procelein till, two drops of methyl-orange indicator were added. This was titrated with O, O_2, NH_2SO_4 to a faint orange colour.

Reaction

$$HCO^-_3 + H^+ \longrightarrow H_2Co_3$$

Calculation

T.A. mg/1 = (B X N X 50,000) / Vol. of sample (in ml.)

Where,

B = ml. of Sulphuric Acid

N = Normality of Acid used.

3. Total Hardness (T.H.)

Total hardness was determined titrimetrically using EDTA method (APHA 1998) To 50 ml of sample taken in a conical flak, one ml of ammonia buffer and

pinch of "Eriochrome black T" indicator was added and titrated against EDTA (Ethyl Diamine Tetra Aceticacid) till colour changed purple to blue.

M^{++} + EDTA $\longrightarrow$ (M.EDTA) complex.

M^{++} + Eriochrome black T $\longrightarrow$ M. Eriochromeblack T (Wine red) complex.

Where,

$M^{++} = Ca^{++}$ and other divalent metal ions causing hardness.

Calculation

$$\text{Total hardness (mg/1)} = \frac{A \times 1000}{\text{Vol. of sample (in ml.)}}$$

Where,

A = ml of titrant used.

Calcium Hardness (Ca.H)

Calcium hardness was determined titrimetrically using EDTA method, one ml of 8% Sodium Hydroxide and 0.2 gram ammonium purpurated indicator was added to 50 ml of sample and titrated against EDTA titrant till pink colour changed to purple in order to determine calcuim as calcium carbonate.

Reaction

Metal indicator $\longrightarrow$ Metal indicator (Complex)

Metal indicator (Complex) +EDTA $\longrightarrow$ Metal-EdTA+Indicator (Complex)

Calculation

$$\text{Calcium Hardness (mg/1)} = \frac{A \times 1000}{\text{Vol. of sample (in ml.)}}$$

Where,

A = ml of titrant

Magnesium Hardness (Mg. H)

Magnesium hardness was calculated by deducting values of calcium hardness from total hardness.

Magnesium Hardness (mg/1) = Total Hardness - Calcium Hardness

Chloride (Cl)

Chloride was determined by mohr's argentometry method (APHA, 1998) in such methods important reactions involved are:

$$NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3 \text{ (till end point)}$$

$$2AgNO_3 + K_2CrO_4 \longrightarrow Ag_2CrO_4 + 2KNO_3$$

(Brick red ppt) (end Point)

Calculation

$$\text{Chloride in mg/1} = \frac{Tv \times N \times 35.45 \times 1000}{\text{Vol. of water sample (ml)}}$$

Where,

Tv = Vol. of titrant

N = Normality of titrant.

Dissolved Oxygen (D.O.)

The dissolved oxygen was estimated by winkler's method using alsterberg azid modification.

The samples were carefully preserved at the sampling stations and the analysis was done with in 6 hour's after collection to avoid any change.

Reagents

(a) Managanese sulfate solution

Weight and dissolved 4800 gm of $MnSO_4 . 4H_2O$ in distilled water, filtered transferred to a 1 litre volumetric flask, and diluted to the mark.

(b) Alkali iodide azide

Weight and dissolved 500 gm of NaOH and 135g of NAI in distilled water, transferred to a 1 litre volumetric flask, and diluted to the mark.

(c) Concentrated Sulphuric Acid

Conc. H_2SO_4 (specific gravity 0.84) was taken.

(d) 0.025 N (N/40) Sodium Thiosulphate

The standard solution (0.1/N) of sodium thiosulphate was prepared by dissolving 24.32 gm $Na_2S_2O_3 . 5H_2O$ in 700 ml of distilled water. Later 4 gm of borax ($Na_2B_4O_7 . 10H_2O$) was added as stabilizer. The solution was made to one litre with distiled water. This solution was diluted four times to form 0.025 N sodium thio Sulphate solution.

(c) Starch Solution

To a suspension of 2 gm powdered starch in 350 ml of distilled water, 30 ml of 20 percent NaOH Solution was added. After stirring well, the alkali was neutralized with HCL using litmus as indicator. The starch solution was acidified with 1 ml of glacial acetic acid.

Procedure

300 ml. of sample was drawn in a BOD bottle without air bubbles and to this were added 2 ml. of manganous sulphate solution and 2 ml. of alkali iodide azide solution. The solution was mixed throughly and after 15 minutes 2 ml. of concentrated sulphuric Acid was added to dissolved the precipitate by various shaking. 50 ml. of solution as indicator. The volume of titrant used in getting the end point (colourless) was noted. D.O. was calculated by the following formulas:-

$$\text{D.O. mg./l} = \frac{\text{ml x N x 8 x 1000}}{V_2[V_2-V_1)/V]}$$

Where,

N = Normality of sodiumthiosulphate solution.

V_1 = Volume of sample Bottle after placing the stopper.

V_2 = Volume of the contents titrated.

V = Volume of manganous sulphate and potassium iodide added.

Biochemical Oxygen Demand (B.O.D.)

B.O.D. gives an idea about the extent of pollution for biochemical oxygen demand required by coliform and E. coli. Method from work book on limnology was adopted B.O.D. was estimated by incubating the sample in B.O.D. Incubator for 5 days at 20^0C and after 5 days dissolved oxygen was fixed and estimated. Difference of initial D_0. & final D_5 gave the total biochemical oxygen demand.

Calculation

$$\text{B.O.D. in mg/l} = \frac{D_0 - D_5}{V}$$

Where,

D_0 = initial dissolved oxygen.

D_5 = D.O. Calculated after 5 days.

V = Decimal volumetric fraction of sample used.

Chemical Oxygen Demand (C.O.D.)

C.O.D. was determined by potassium dichromate Reflux method [NEERI, 1986.] 20 ml of sample water was taken in a 200 ml flask. The 10 ml of 0.25 N Potassium dichromate, 30 ml of cone. H_2SO_4 a pinch of silver sulphate and mercuric sulphate were added and refluxed for two hours in a water bath. After two hours

distilled water was added to make its volumes 140 ml. 2 to 3 drops of ferroin indicator was added to refluxed sample, mixed thoroughly and treated with 0.25 N ferrous ammoniam sulphate till a brick red colour end point is obtained.

Reaction

$2K_2Cr_2O_7 + 8H_2SO_4 \longrightarrow 2K_2(SO_4)_3 + 3O_2 + 2Cr_2(SO_4)_3 + 8H_2O$

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

$Cr_2O_7^{-2} + 6Cl + 14H^+ \longrightarrow 3Cl_2 + Cr^{+3} + 7H_2O$

$Hg^{+2} + 2Cl \longrightarrow HgCl_2$

Calculation

C.O.D. in Mg/1 = (A-B) x N x 8000/Vol. of sample (in ml.)

Where,

A = ml. of titrant used with sample.

B = ml. of titrant used with blank.

N = Normality of $FeSO_4 (NH_4)_2 SO_4 6H_2O$.

Carbon di-oxide (CO_2)

As a free carbon di oxide is liable to escape easily from the water, it is highly desirable that analysis be made soon after the collection of the sample (welch 1948). For this the analysis was done in the field according to the standard method of APHA.

Reagents

(a) Phenolphathalein indicator

0.5 percent solution of phenolphthale in indicator was prepared by dissolving 500 mg of phenolphthalein in 100 ml of 50 percent alcohol.

(b) N/44 Sodium Hydroxide Solution

0.1 N Sodium hydroxide solution was prepared by dissolving 4 gm. Sodium hydroxide (A.R.) in distillted water and than made to 1000ml. which was standardised against 0.1 N sulphuric acid, Using phenolphthalein as indicator, 100 ml. of this 0.1 N solution was dilute to 440 ml with distilled water, to form N/44 sodium hydroxide solution.

Procedure

100 ml. of sample was taken in a beaker and four drops of the phenolphthalein indicator were added to it. If the water turned pink it showed the absence of free CO_2, on the other hand if remained colourless, the free carbon di oxide was present. If the free carbon di oxide was present than the solution was titrated with N/44 sodium hydroxide solution till a distinct pink colour developed, which flashed for a few seconds through out the solution. The volume of the titrant used was noted and CO_2 estimated.

Calculation

$$\text{Free } CO_2 \text{mg/l} = \frac{A \times N \times 1000 \times 44}{\text{ml. of sample}}$$

Where,

A = ml of sodium hydroxide solution.

N = Normality of sodium hydroxide solution.

Ammonical Nitrogen (NH_4-N)

Direct nesslerization method was adopted for this parameter. To 50 ml of sample, 5 drops of Rochelle salt solution and two ml of Nessler's reagent was added. After ten minutes intensity of colour was measured on spectrophotometer at 420 mm wave length. The value of NH_4-N was obtained from standard curve.

Nitrite Nitrogen (NO_2-N)

1 ml of each sulfanilic acid Naphtylamine Hydrochloride and sodium acetate solutions in sequence were added in 50 ml of colourless filtered sample. A wine red colour of Nitrite appeared and determined at 520 nm wave length and the value of No_2-N was calculated in mg/l directly from the standard curve.

Nitrate Nitrogen (NO_3-N)

Phenol di sulphonic Acid method was chosen for this parameter 50 ml of water sample was evaporated in water bath. Residue was dissolved in 1,2,4 phenol di sulphonic acid on addition of ammonia solution yellow colour alkaline salt was formed and determined at 510 nm wave length. Value of NO_3-N in mg/l was found out by standard curve.

Phosphate (PO_4)

Phosphate was determined on Spectrometer by stannous chloride method. To 50 ml of sample, 20 ml of Ammonium Molybdate solution and 6 drops of stannous chloride was added and colour was allowed to develop for five minutes. Absorbance was noted on spectrophotometer at a wave length of 690 nm and concentration of phosphate in mg/l was calculated from standard graph.

Sulphate (SO_4)

40 ml. water sample was taken into 100 ml cylinder, followed by 10 ml. Barium chroride solution. The sample was shaken and kept standing for 15 min. The reading of developed turbidity was measured on UV-VIS spectrometer at 420 nm. The concentration of sulphate was calculated by standard curve. Results were expressed in mg/Litre.

Sodium (Na)

Sodium determination was carried out by using systronics make flame photometer. The instrument was calibrated with standard sodiumchloride solution. Then the sample was sprayed in ten gas flame and the excitation was measured at 589 nm.

Potassium (K)

Potassium determination was carried out by using flame photometer. The instrument was calibrated with standard solution of potassium chloride. The potassium determination was carried out at 768 nm.

Fluoride (F)

Reagents

(a) SPADNA Solution

Dissolved 958 mg SPADNA, Sodium 2- (Parasulfophenylazo) 1,8-dihydroxy- 3, 6 - naphthalene disulfonate, also called 4-5 dihydroxy -3- (Para sulfophenylazo) - 2, 7- naphthalene disulfonic acid trisodium salt, in distilled water and diluted to 500 ml.

(b) Standard fluoride solution

Diluted 100 ml stock fluoride solution to 100 ml with distilled water. 1.00 ml = 10.0 ug F.

(c) Zirconyl acid reagent

Dissolved 133 mg zirconyl chloride octahydrate, $ZrOC_2 . 8H_2O$ in about ml distilled water. Added 350 ml cone HCl & diluted to 500 ml with distilled water.

(d) Acid zirconly-SPADNS reagents

Mixed equal volumes of SPADNS solution and Zirconyl acid reagent.

(e) Sodium arsenite solution

Dissolved 5.0g $NaAsO_2$ and diluted to 1 liter with distilled water.

(f) Reference Solution

Added 10 ml SPADNS solution to 100 ml distilled water. Diluted 7 ml cone. HCl to 10 ml and add to the diluted SPADNS solution.

Procedure

(a) Preparation of standard curve

Prepared fluoride standard in the range of 0 to 1.40 mg F/L diluting appropriate quantities of standard Fluoride solution to 50 ml with distilled water. Pipette 5.00 ml each of SPADNS solution and Zirconyl acid reagent or 10.00 ml mixed acid Zirconyl SPADNS reagent to each standard and mixed well. Avoided contamination; Set spectra photometer to Zero absorbance with the reference solution and obtained absorbance readings of standards. Ploted a curve of the milligrams fluoride absorbance relationship. Prepared a new standard curve whenever a fresh reagent is made or a different standard temperature is desired. As an alternative to using a reference, set spectrophotometer at some convenient point (0.300 or 0.500 absorbance) with the prepared 0 mg. F^{-}/l standard.

(b) Sample pretreatment

If the sample contained (Sodium arse) residual chlorine, removed it by adding 1 drop (0.05 ml) $NaAsO_2$ solution/ 0.1 mg residual chlorine & mixed.

(c) Colour development

Used a 50.00 ml sample or a portion diluted to 50 ml with distilled water. Adjusted sample temperature to that used for the standard curve. Add 5.00 ml each of SPADNS solution and Zirconyl acid reagent, or 10 ml acid zirconyl. SPADNS solutions and zirconyl acid reagent, or 10 ml acid zirconyl-SPADNS reagent mixed well and read absorbance, First setting the reference point of the photometer as above. If the absorbance falls beyond the range of the standard curve, repeat using a diluted sample.

Calculation

$$\text{mg F}^-\text{/L} = \frac{A}{\text{ml sample}} \times \frac{B}{C}$$

Where,

A = ugf determined from plotted curve

B = final Volume of diluted sample, ml and

C = Volume of diluted sample used for colour development, ml.

When the prepared 0 mg F^-/L standard is used to set the photometer, alternatively calculate fluoride concentration as follows:

$$\text{Mg F}^-\text{/L} = \frac{A_0 - A_2}{A_0 - A_1}$$

Where,

A_0 = absorbance of the prepared 0 mg F^-/L standard.

A_1 = absorbance of the prepared 1.0 mg F^-/L standard.

A_2 = absorbance of the prepared sample.

Heavy Metal Analysis- (Zn, Mg, Fe)

The analysis of the heavy metals was carried out using a per kielmer 2380 atomic absorption spectrophotometer with graphite furnace and hallow cathod lamp. for the preparation on calibration curves, standard solutions were prepared using BDH standard chemicals. The solutions of 1000mg/l strength for each metal were prepared using the methods prescribed in the spectrophotometer. The standard solutions were then diluted suitable.

Biological Factors

Analysis Technique

Bacteriological Examination

Extreme precaution is needed for collection of samples for bacteriological analysis. Usually the samples are collected from the marginal waters, which was badly contaminated and disturbed due to various human activities.

Estimation of total coliform to detect the bacteria in water. The chief objectives were to identify that water contains faecal pollution and was unsafe for consumption. Coliforms were gram negative bacteria, which were rod shaped and usually inhabited the gastrointestinal tract. The coliforms which were present in the faecal waste, were called the faecal coliforms. Faecal and non faecal coliforms are together called total coliforms. The most important and convenient is the Most Potable Number (M.P.N.) technique which was followed for the present research.

Total Qualiform (M.P.N.) Procedure

In this procedure water samples in to a no. of tubes of medium (Mc. Conkey's Broth). 10 ml, 1 ml and 0.1 ml amount was inoculated in to sterilized lactose broth tubes. The ignition tube was placed in each test tube. The tubes were incubated at

35^{0}C to 37^0 C. Caliform organisms were identified after 24 hours by their production of gas from the lactose. By refering to a M.P.N. table, a statistical range of the number of coliforms were determined by observing how many broth tubes showed gas formation. The tubes showing the positive tests were subjected to a confirmatory test.

The presence of coliforms were confirmed by streaking samples form the positive lactose broth cultures on to Eosin Methylene Blue Agar (E.M.B.). Faecal coliforms showed a characteristics greenish metallic seen, the non faecal coliform exhibited dark reddish colonies whereas the non coliform showed colourless colonies.

Calculation

$$\text{MPN/100 ml} = \frac{\text{No. of positive tube} \times 100}{\sqrt{\text{Total sample (ml) in negative tube} \times \text{total sample in test}}}$$

Phyto and Zooplankton

The plankton density usually diminishes from the phyto-zooplankton margin to mid stream and also in down wards surface. Maximum population was recorded in the marginal and surface water but this may not give the over all picture as some of the plankton prefer surface region. Morover vertical migration of plankton keeps on fluctuating with the light intensity temperature and co-contents during the diel cycle. There was also some variation is plankton density on the two opposite banks of the river. It was generally higher on that side of the river which has greater human settlement correct conclusions about plankton density and diversity can be down only when the sample were collected from the cross section of the river. Therefore the samples were collected from the cross section of the river.

Sampling Process

Planktons are very sensitive to water temperature, solar radiations, D.O. and nutrient levels of the water. I have observed a marked variation in the vertical movement of plankton during the diel cycle which is obviously on account of variations in some of the important physico-chemical aspects of water practically all the groups of phyto-plankton are sensitive to light, therefore by and large their activity was brisk during the morning hours. The time consider with the feeding time of the zooplankton in early hours. It may be pointed out that the plankton population during the noon diminishes due to down word migration of zooplankton. Morover due to changes in the osmoregulatory process and buoyancy of the phyto-phankton round the clock has shown that maximum plankton density was between 8.00 am to 9.30 am while stock. Therefore the sample the study of planktons were collected by boat from such places related to the different stations.

The phyto and zooplankton were collected by means of plankton net (Welch 1948) and preserved in 4% formalin at the sampling site. The bolting silk No. 25 (65n) was used in the net. Which is attached with an iron ring of about 20 cm. diameter in conical shape. The open tail side is about 2.3 cm. in diameter was tid firmly to a glass tube measuring 5 cm. in length and 2 cm. in diameter. In each collection 100 litre of surface water was collected by means of a jug, which was filtered through the plankton net. The filtrate thus contains planktons (Photo & Zooplankton) 10 ml. of the filtered was preserved in 4% formalin at the spot. The quantitative and qualitative examinations were done in the laboratory by the standard methods (APHA 1995) and Goyal and Trivedi (1986). Before qualitative analysis each plankton sample was diluted and mixed with water to make it to 50 ml., 1ml of

this sub sample was drawn quickly with a wide mouthed pipette and poured into a Sedgwick-Rafter plankton counting cell. All the organisms were identified up to genus level . Analysis of each genus was than calculated as No./Litre of the water by the formula given by Welch's (1948).

$$n = (a \times 100)\ c/l$$

Where,

n	=	No. of plankton per litre.
a	=	Average No. of plankton in all count in a counting cell.
c	=	Volume of Original water expressed in litre.
l	=	Volume of original water expressed in litre.

For the qualitative analysis the sample were examined under high power (10 x 100) of the microscope and identified by taking help of standard books and publications. (A.P.H.A., 1995; Goyal & Trivedi, 1986; Welch, 1948).

Fishes

The fish were collected during night and also in early morning by Drag net and also with vertical nets (100' x 5') with a mesh (3' x 5') in diameter and they were identified with the help of Francis Day Fauna and also with Gopal Ji Srivastawa for identification of fishes.

A quatic Weeds

The sample of aquatic weeds were collected and their abundance was assessed by visual observations and identified up to Subramanyam (1962).

Meteorological data are recorded for the period of two years i.e. (2005-2006) from Collectrate Office at Nagpur and their means values were calculated.

OBSERVATION

OBSERVATION

Water is one of the essential requirements of life a surve. It provides subtances to plants and animals, Constitutes the habital for aquatic organisms and meets important agricultural and industrial needs. Water indergoes both seasonal and yearly fluctuations and subject human made changer and in their Physico-chemical and Biological qualities.

The monthly mean value of various physico-chemical and biological factors of Mandaki River water have been studied for two years from Jan., 2005 Dec., 2005 to Jan., 2006 - Dec., 2006 for which monthly fluctuations with average value, standard deviation and co-efficient corelation have been tabulated. The polluted environment is by ill changes in the ecology of place flora and fauna which brings about altrnation in the ecosystems and ultimately causes enviromental pollution.

Meterological Conditions

Atmospheric temperature, Relative humidity, Rainfall and photo period.

Physical Factors

Water temperature, Colour, Turbidity, Water Current.

Chemical Factors

p^H, Total alkalinity, Total hardness, Ca hardness, Mg hardness, Chloride, D.O, BOD, COD, CO_2, Ammonical nitrogen, Nitrite nitrogen, Nitrate nitrogen Phospate (PO_4), Sulphate (SO_4), Sodium (Na), Potasium (K), Fluoride (F).

Biological Factors

Phytoplankton, Zooplankton, MPN, Aquatic weeds, economically important fishes.

Meteorological Conditions

As regards these conditions i.e. Rainfall, relative humidity, and Photo period; their monthly mean values were recorded during the period of two years study. (Jan. 2005 to Dec. 2006).

Atmospheric Temperature

During the investigation period from Jan. 2005 to Dec. 2005, it varied from 10.2 to 41.4 and in 2006 to Dec. 2006 ranged between was 11.2 to 41.3. The minimum degree was recorded in the month of January in 2005 while in 2006 the month was december. Whereas highest was observed in summer season in the month of may in both the years. It was observed that increase or decrease of atmospheric temperature depends on relative humidity, Photoperiod and Rain fall.

Rain fall

In the first year Jan. 2005 to Dec. 2005 , It varied from 4.9 to 757.8 and in second year, Jan. 2006 to Dec. 2006, it ranged between 0.6 mm. to 452.2% mm.

Lowest rainfall was recorded in the month of Oct. 2005 and in 2006 the month was Nov.. Whereas highest was observed in the month of July in both the years whereas in the months of May, November and December in 2005 rainfall nil and in the months of Jan, Feb. Dec., in the year of 2006 rainfall was also nil.

So, it was noticed that highest rainfall depend upon monsoon.

Relative humidity

Humidity during the present study period 2004-2005 varied from 16.37% to 86.29% and in 2005-2006 ranged between 18.68% to 86.74% . Lowest was recorded in April while the highest was observed in July in both the years.

It is effected by rainfall and atmospheric temperature.

Photoperiod

It varied from 10.47 hrs. and 13.54 hrs. in 2005 and in 2006 ranged between 10.54 hrs. to 13.64 hrs. Lowest Photoperiod was recorded in December while the highest was observed in June. in both the years. It depends on the rotation of the planed earth which moves around the sun through cabricorn to cancer or solar radiation.

Physical Factors

In the present study the Physical nature of water by taken the factors, water temperature, Turbidity, Colour: and water current.

Water Temperature

The water Temperature varied from 18.04^{0}C to 33.05 ^{0}C. in 2005 and between 17.00 ^{0}C to 33.65 ^{0}C in the year 2006 at four deferent sampling stations. Minimum mean value was recorded in winter season (Jan.) in both the years whereas. Maximum value was observed in the month of Summer season (June) in both the years. It is directly effected by atmospheric temperature.

Turbidity

It varied from 14.00 to 79.00 N.T.U. in 2005 and 15.10 to 90.00 N.T.U. in 2006. Maximum turbidity was observed in the month of August while the minimum average value was observed in the month of Dec. in the bothe the years. The higher tendency of turbidity was observed during monsoon and summer season due to siting, flow of surface run off in the rainy season.

Water Current

It varied from 7.0 to 1000.9 Cum/second in 2005 and in 2006, 6.4 cu. cm./ Sec. to 1016.0 cum./Sec. at all sampling stations.

Maximum water current rainy season in August and minimum was observed in winter i.e. Jan. in both the years. The highest value was observed in the monsoon period due to high rain fall and wind velocity.

Colour

The colour of water in Mandakini river was found to very greenish to muddy. The greenish colour of the water observed in the month of October to May. In June to Sep. months the muddy colour was noticed.

Water colour of the river was depend upon the growth of Algae. Phytoplankton and Turbidity.

Chemical Factors

Hydrogen-ion-Concentration (pH)

During the present study period the p^H value was observed from 7.00 to 8.71 whereas in 2005 ranged between 7.10 to 8.80. The lowest P^H Value was observed in the month of January 2005-2006 whereas the highest value was founded in the month of June both in the years. The pH value of the river water was found in alkalini range.

It was observed that the CO_2 concentration affects pH of water.

Total Alkalinity (T.A.)

During the present study period the value of alkalinity varied from 210.0 to 278.0 mg/l in 2005. Whereas in 2006 it ranged between 213.0 to 282.0 mg/l.

Maximum average value was recorded in the month of June and Minimum values was found in August in both the years of study.

It was noticed that total alkalinity depend upon pH and hardness of water.

Total Hardness (T.H.)

During the present study the value of total hardness was noted 150.0 mg/l to 230.0 mg/l in 2005 while in 2006 it was found between 150.0 mg/l to 240 mg/l. The maximum average of this factor was found in the month of June while minimum value recorded in the month of August during the entire period of study. It particularly reveals the nature of water of the river.

It was observed that total hardness is directly affected by alkalinity and pH of river water.

Calcium Hardness (Ca.H.)

In the present study the value of total hardness was noted 20.0 mg/l to 60.0 mg/l in 2005 while in 2006 it was found between 22.0 mg/l to 70.0 mg/l. The maximum average value of this factor was noted in the month of June and the minimum value observed in the month of August in the study period.

On an average significant increase in Ca.H. was observed during summer due to less diluation.

Magnesisum Hardness (Mg.H)

In the present study it varied from 138.0 mg/l to 180.0 mg/l in 2005 where as in 2006 it ranged between 138.0 mg/l to 190.0 mg/l. The highest value was observed in the month June and Lowest value was found in the month of March.

It was seen that it is directly related by calcium hardness of river water.

Chloride (Cl)

In present study the range of fluctuation was between 2.0 mg/l to 9.0 mg/l in 2004 and in 2005 it was observed between 1.85 mg/l to 9.10mg/l. The maximum concentration of this factor was recorded in the month of may whereas minimum concentration was recorded the month of August in the entire study period. High concentration due to more organic wastes decomposition sewage discharges and less volume of water.

Dissolved Oxygen (D.O.)

Dissolved Oxygen is a very important parameter of water quality. During the course of investigation the D.O. level of river was varied from 4.10 mg/l to 7.95 mg/l in 2005 and in 2006 ranged between 4.11 to 7.80 mg/l. Maximum level of it was observed in the month of January in both the years while minimum value was observe in the month of June in both the years. It was found that D.O. concentration level was affected by the zooplanktons density, total coliform, and temperture.

Carbon di- oxide (CO_2)

In the course of investigation it ranged between 1.40 mg/l to 4.40 mg/l in 2005 and in 2006 1.60 mg/l to 5.40 mg/l. Highest value found in the month of June and lowest value was noticed in the month of January in both the years.

It was observed that CO_2 adversely effects D.O. and zooplanktons density increases CO_2.

Bio-chemical oxygen Demand (B.O.D.)

In the present investigation of river water B.O.D. varied between 0.05 mg/l to 1.50 mg/l in 2005 and in 2006 0.11 mg/l to 2.15 mg/l. The maximum value was

observed in the month of June and the minimum average value was recorded in the month of August. It determines the pollution power of sewage discharges in water. It was B.O.D. affected by bacteria which develop in organic matter.

It is observed that B.O.D. is directly related with Cl and C.O.D.

Chemical Oxygen Demand (C.O.D.)

In the course of investigation it ranges between 0.00 mg/l to 14.10 mg/l in 2005 and in 2006 it ranged between 0.00 mg/l to 14.00 mg/l. The maximum value was observed in the month of June.

A direct relationship was observed between B.O.D. and C.O.D. Toxicity of water was found responsible these factors. The C.O.D. indicates toxicity along with be presence of organic substance which have biological resistance. So, C.O.D. is the indicator of water pollution. It is observed that C.O.D. is always greater than B.O.D. values.

Ammonical Nitrogen (NH_4N)

In the present finding NH_4-N varied between 0.00 mg/l to .052 mg/l in 2005 and in 2006 ranged between 0.00 mg/l 3.10 mg/l.

The maximum concentration was noticed in the month of June in both the years whereas minimum concentration was noticed in August in both the years.

Ammonical Nitrogen is an important parameter to know the toxicity of water. The increase trend was seen in summer and post monsoon period. Which was due to reduced quantity of water. Sewage has large quantities of nitrogenous matter, which increases ammonia contents of the water enhances Ammonical Nitrogen which showed pollution.

Nitrite Nitrogen (NO_2-N)

Nitrite is found in a very low concentration in natural waters. In the course of study it varied between 00.0 mg/l to .0050 mg/l in the year 2005 and in 2006 it ranged between 0.00 mg/l to 0.270 mg/l. Maximum value was observed in the month of August in both the years. The value of found corresponding to that of ammonical nitrogen.

Nitrate Nitrogen (NO_3-N)

In the course of study its concentration varied from 1.00 mg/l to 1.90 mg/l and in second year of study it fluctuated between 1.00 mg/l to 2.20 mg/l. The highest value was observed in the month of June whereas Lowest value was recorded in the month of August in both the years.

Nitrate which is commonly present in natural water is the most highly oxidized from of nitrogen compounds. It plays an important role in eutrophication of water, along with phosphates. And it is affected by excretory matters.

Phosphate (PO_4)

In the present findings the concentration of river water was found in the .0007 mg/l to .0488 mg/l in 2005 and in 2006 ranged between .0017 mg/l to .0489 mg/l. The maximum average value was recorded in the month of August . While minimum value was found in the month February in both the years.

It is the important plant nutrients and are readily taken up by planktons. It is observed that considerable irregular increases in the concentration of phosphate indicates the presence of pollutants. It's higher concentration was found in rainy month which may be due to storm and run off.

Sulphate (SO_4)

During the present study sulphate content was observed in the range 0.42 mg/l to 3.10 mg/l in the first year of study while in the second year of study it was found in the range of 1.52 mg/l to 3.89 mg/l. The maximum and minimum Values where found in month of June and August in the both the study years.

Sulphate is an important constituent of total hardness with calcium and magnesium, discharge of domestic sewage water tends to increase its concentration.

Sodium (Na)

Its value varied from 6.00 mg/l to 39.13 mg/l in 2005 the sodium content fluetuated between 7.11 mg/l to 40.00 mg/l. The maximum value was observed in the month of August and minimum value was found in the month of January throughout the study span. Na along with Ca and Mg form the major fraction of total cations. Their concentration are in order of Ca^{++}/ Mg^{++}/Na^{+}, till the water quality is not interfered by human activities. It is higher value was found due to domestic wastes and discharges.

Potassium (K)

In present findings its concentration was found in the range of 1.50 mg/l to 30.12 mg/l in 2005 and in 2006 varied from 1.70 mg/l to 38.12 mg/l. The maximum and Minimum values of it were found in the month August and minimum January in the entire study span.

It is one of the principal ' ion' involved with water quality. Its higher concentration was found in rainy season due to leaching from soil.

Fluoride (F)

During the present study the value of it varied between 0.10 mg/l to 0.49 mg/l in 2005 and in 2006 it ranged between 0.00 mg/l to 0.78 mg/l. The highest value found in the month of September and Lowest value was noticed in the month of November in both the years. It is concentration is effected by floods.

Heavy Metals

During the present study the concentration of examined metals viz, iron, Manganese and zinc from the water samples of river Mandakini showed that the metals concentration was negligible in both the years, observations showed that the metals cuncentration increased both by geological factors and due to addition of waste materials. Most of the metals actively precipitate in natural processes and therefore the concentration of metals is subject to regular seasonal changes.

Biological Factors

Total coliform (M.P.N.), Plankton aquatic weeds and fishes were observed under biological factors in two years of study period, June 2005 to Dec. 2006.

Total Coliform (M.P.N.)

In the present investigation the total colifrom was observed in the range of 58.0/100 ml to 1600.0/100 ml. in the first year 2005 while in the second year 2006 of the study span it was observed in the range of 55.0/100/ml to 1789.0/100 ml. The maximum concentration was noticed in the month of August whereas the minimum concentration was found in the month of January in the both years. Al all station higher range of M.P.N was noticed during summer and monsoon season. It's range was found to be effected by organic matter decomposition in mansoon and summer season. Bacteriological analysis is essential for assessment of quality of water.

Plankton

Phytoplankton (Microflora)

In the present observation only dominant groups of phytoplankton were studied quantitavely and qualitatively and identified upto genus which are-

Qualitative observation

Chlorophyceae

It comprises 12 genera in qualitative study the under mentioned genera were observed.

(1)	Ankistrodesmus	(2)	Chlorella	(3)	Cosmarium
(4)	Eudorina	(5)	Hydrodicton	(6)	Microspora
(7)	Mougeotia	(8)	Pandorina	(9)	Pediastrum
(10)	Spirogyra	(11)	Ulothrix	(12)	Zygnema

Quantitative Observation

During the present investigation group chlorophyceae varied from 17.0 org/l to 154.0 org/l in 2005 whereas in 2006 it ranged 11.0 org/l to 169.0 org/l.

Qualitative observation

Bacillariophyceae

It comprises mainly 8 genera. The qualitatively were observed:

(1)	Amphipleura	(2)	Coconies	(3)	Fragillaria
(4)	Gomphonema	(5)	Nitchia Palaea	(6)	Synedraacus
(7)	Tabelloeria	(8)	Pinnularia		

Quantitative Observation

This group was observed in the range of 03 org/l to 114 org/l in 2005 while in 2006 it was found in the range of 04 org/l to 102 org/l.

Qualitative Observation

Cyanophyceae

It consisted mainly 7 genera i.e.-

(1)	Agmenellum	(2)	Anabaena	(3)	Cylinderospernum
(4)	Rivularia	(5)	Microcoleus	(6)	Vaucharia
(7)	Phormidium				

Quantitative Observation

This groups ranged from 12.0 org/l to 92.0 org/l during the period of 2005 while in 2006 ranged between 11.0 org/l to 95.0 org/l.

The populations of Phytoplankton has been presented in tables.

(B) Zooplankton (Microfauna)

The zooplankton population mainly consisted of Protozoans, rotifers and crustaceans, in the present irestigation. Qualitatively idientified and quantitatively density was studied as follows.

Group (a)

I Protozoa

It was consisted mainly 7 genera i.e.

(1)	Acanphocystis	(2)	Arcella	(3)	Euglena
(4)	Euglypha	(5)	Metopus	(6)	Paramecium
(7)	Verticella				

Quantitative investigation

Group protozoa varied from 02 org/l to 92 org/l during the period of 2005 and in 2006 ranged from 01-0 org/l to 105 org/l. (Table)

Group (B)

II Rotifera

It was consisted 5 genera i.e.

1.	Asplanchna	2.	Brachionus	3.	Fielina
4.	Keratella	5.	Testudinella		

Quantitative investigation

Group rotifera ranged from 060 org/l to 87 org/l during the period of 2005 and varied in 2006 from 05.0 org/l to 87 org/l. (Table)

Group (C)

Crustacean Larvae

(i) Cladocera

It was consisted mainly 5 genera i.e.

1.	Alonella	2.	Ceriodaphnia	3.	Daphnia
4.	Moina	5.	Oxyurella		

Quantitative investigation

Sub group cladocera varied from 04 org/l to 85 org/l during the period of 2005 and in 2006 ranged from 03 org/l to 100 org/l. (Table)

(ii) Copepoda

It was consisted mainly 6 genera i.e.

1.	Allodiaptomos	2.	Cyclops	3.	Diaptomus
4.	Ergasilus	5.	Macrocyclops	6.	Mesocyclops

Quantitative investigation

This Sub-group copepoda varied from 09 org/l to 79 org/l during the period of 2005 and in 2006 varied from 09 org/l to 83 org/l. (Table)

Aquatic Weeds

During the course of study " Jan. 2005 to Dec. 2006" various form stations of Mandakini river which are:-

The various forms of the aquatic weeds were observed during both the years of study from different four stations of the river Mandakini they are:-

S.N.	Name of Species of weeds	Types of Weeds
1	Azolla Spp.	Free Floating
2.	Azolla pinnata	Free Floating
3.	Ceratophyllumsp	Submerged
4.	Ceratophyllum demersum	Submerged
5.	Cyperus corymbosus	Submerged
6.	Chara spp.	Submerged
7.	Eichhornia crassipes	Free Floating
8.	Hydrilla verticellata	Submerged
9.	Impomoea aquatica	Emergent weeds.
10.	Isoetes	Submerged
11.	Lemna paucicostata	Free Floating
12.	Nechamandra altemifolia	Submerged
13.	Najas Graminea	Submerged
14.	Nypheaea stellata	Free Floating
15.	Nymphoides cristatum	Floating Level Weeds
16.	Nitella spp.	Submerged
17.	Nilumbo spp.	Free Floating
18.	Pisitia stratoites	Free Floating
19.	Potamogeton indicus	Submerged/F.L.

20.	Potamogeton crispus	Submerged
21.	Patamogeton pectinatus	Submerged
22.	Potamogeton perfoliatus	Submerged
23.	Ottelia alismoides	Submerged
24.	Spirodella Pollyrrhiza	Free Floating
25.	Scripus articulatus	Emergent weeds
26.	Salvinia	Free Floating
27.	Trapa natans	Free Floating
28.	Valisnaria spiralis	Submerged
29.	Wolffia	Free Floating

Fishes

occurance of economically important fishes is ristricted due to the ecological and hydrological features of the river. The most important macro fauna in rivers is fishes. So the fishes which are found in this river during the course of study were dagedout identified and grouped as per their Biosystematics position- along with their local names which are as under- Bigger forms are frequent in deep and rapid waters almost through out the year, but the shallow waters are completely devoid of these forms due to intense fishing.

Classified List of Fishes in Mandakini River

	Species	Local Name
I	**Family- Clupeidae**	
(1)	Gudusia Godanahiai	Godanalia Suhia
(2)	Gudusia Chapra (Ham)	Suhia
(3)	Gonialosa manmina (Ham)	Majhali Suhia

II Family-Notopteridae

(1)	Notopterus notopterus (Ham)	Patra
(2)	Notopterus Chitala	Moya

III Family-Cyprimdae

Sub Family -Abramidinae

(1)	Oxygasterbacaila	Chelhwa

Sub Family-Rasborinae

(1)	Barilius Bola (Ham.)	Ghilra
(2)	Barilius barila (Ham)	
(3)	Catla Catla (Ham)	Bhakur, Catla
(4)	Chaguius Chagunio	Chhagua
(5)	Chela Atpar	Chelhwa
(6)	Cirrhinus mrigala (Ham)	Nain
(7)	Cirrhinus reba (Ham)	Raiya
(8)	Esomus danricus	Dendya
(9)	Garoa Gotyla (Ham.)	Siltaka
(10)	Labeo bata (Ham)	Bata
(11)	Labeo Calbasu	Karaunchar
(12)	Labeo Pangusia	Loanee or Rewa
(13)	Labeo Rohita	Rohu
(14)	Puntius Chola	Sidhari
(15)	Puntius Sarana	Darahee
(16)	Tor Tor	Mahasheer

IV Family Cobitidae

(i)	Noemacheilus botia (Hill stream)	Carri ornatwa

Sub Family-Cobitini

(2)	Lepidocephalichthyes guntea (Hill stram)	Nakati
V	**Family- Siluridae**	
(1)	Wallago attu	Pardhani, Barari
VI	**Family- Bagridae**	
1.	Mystus tengara	Katua
2.	Mystus aor	Dariae Tengar
3.	Mystus seenghala	Seenghala or Tengar
4.	Rita rita	Gigra or Hunna
VII	**Family- Schilbeidae**	
1.	Eutropiichthysvacha	Bachuwa
VIII	**Family- Saccobrachidae**	
1.	Heteropheustes Fossilis	Singhi
IX	**Family- Clariidae**	
1.	Clarias batrachus	Mangur
X	**Family- Belonidae**	
1.	Xenentodon Cancila	Sua
XI	**Family- ophiocephalidae**	
1.	Channa punctatus	Girai
2.	Channa Marulius	Padamsaur

XII Family- Centropomidae

1.	Chanda Nama	Chanda
2.	Chanda Ranga	Chanari

XIII Family- Nandidae

1.	Nandus nandus	
2.	Badis badis	Sumha

XIV Family- Mastacembilidae

1.	Mastacembelus armatus	Bam

Table-1

Meteorological Data

Monthly Avarage for the Year 2005

S.No.	Month	Atmosperic temperature		Relative humidity %		Rain fall	Photo period
		Max. ^{0}C.	Min. ^{0}C.	Morning	Evening	MM.	Hrs
1	January	23.60	9.60	79.77	54.29	18.40	10.64
2	February	27.20	12.80	70.03	41.32	5.40	11.19
2	March	33.20	18.80	56.70	31.51	40.90	11.89
4	April	38.20	21.70	30.93	16.37	6.40	12.63
5	May	41.40	26.60	31.83	17.26	0.00	13.24
6	June	41.10	29.00	50.73	35.97	115.10	13.54
7	July	31.30	25.30	86.29	79.23	757.80	13.40
8	August	31.20	24.80	83.70	70.71	249.20	12.88
9	September	32.50	24.20	82.50	74.47	192.30	12.18
10	October	31.70	20.60	76.42	50.29	4.90	11.93
11	November	28.80	12.70	63.73	36.23	0.00	10.80
12	December	25.20	10.20	66.77	41.06	0.00	10.47

Table-2

Meteorological Data

Monthly Avarage for the Year 2006

S.No.	Month	Atmosperic temperature		Relative humidity %		Rain fall	Photo period
		Max. ^{0}C.	Min. ^{0}C.	Morning	Evening	MM.	Hrs
1	January	26.30	18.60	63.16	32.87	0.00	10.71
2	February	32.10	14.10	59.21	24.36	0.00	11.26
2	March	31.40	17.20	53.55	30.23	34.20	11.96
4	April	38.70	22.80	36.48	18.68	24.20	12.69
5	May	41.30	28.50	45.42	27.87	25.00	13.33
6	June	39.00	28.50	55.23	43.80	53.30	13.64
7	July	31.30	26.10	86.48	76.97	452.10	13.49
8	August	31.50	24.80	86.74	77.78	171.50	12.96
9	September	32.90	24.30	75.03	62.18	46.10	12.25
10	October	33.70	20.70	62.71	37.58	11.50	11.51
11	November	29.10	15.50	66.63	39.60	0.60	10.88
12	December	27.20	11.20	69.06	42.29	0.00	10.54

Table-3

Physico-Chemical Characteristics of Mandankini River

Station No.-1

Year : 2005

Month	W.T. (^{0}C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm./Sec.)	pH	T.A. (Mg/Lt.)	T.H. (Mg/Lt.)	CaH (Mg/Lt.)	MgH (Mg/Lt.)	Cl (Mg/Lt.)	D.O. (Mg/Lt.)	B.O.D. (Mg/Lt.)	C.O.D. (Mg/Lt.)	NH_4-N (Mg/Lt.)	NO_2-N (Mg/Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/Lt.)	Na. (Mg/Lt.)	K (Mg/Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/Lt.)	MPN (Org/Lt.)
Jan	19.04	16.00	Greenish	9.1	7.00	221.0	172.0	40.0	144.0	3.0	5.40	0.14	0.01	0.02	0.0140	1.19	0.0018	2.08	6.00	4.00	1.40	0.17	58.0
Feb	22.00	18.00	Greenish	10.6	7.20	224.0	175.0	32.0	140.0	3.5	5.35	0.15	0.00	0.02	0.0127	1.35	0.0007	2.06	19.31	6.20	1.60	0.12	79.0
Mar	24.10	19.00	Greenish	14.4	7.25	225.0	170.0	31.0	138.0	5.0	5.30	0.16	0.00	0.02	0.0129	1.35	0.0017	2.05	19.50	6.25	1.80	0.22	85.0
Apr	29.00	21.00	Greenish	12.0	7.27	226.0	173.0	34.0	148.0	7.2	5.25	0.17	0.01	0.02	0.0132	1.38	0.0022	2.09	19.66	6.38	2.00	0.12	90.0
May	31.06	30.00	Greenish	7.7	7.28	227.0	194.0	42.0	152.0	9.0	5.20	0.20	0.01	0.02	0.0150	1.39	0.0030	2.09	19.70	6.85	2.40	0.15	92.0
Jun	32.15	40.00	Greenish	7.0	8.30	259.0	198.0	50.0	158.0	8.2	4.94	0.55	0.02	0.05	0.0250	1.54	0.0038	2.50	19.90	6.88	4.00	0.18	100.0
Jul	30.11	46.00	Muddy	300.1	7.26	228.0	160.0	40.0	151.0	7.0	5.00	0.23	0.01	0.04	0.0139	1.30	0.0040	2.40	19.92	6.93	3.00	0.05	150.0
Aug	30.01	55.00	Muddy	1000.9	7.24	210.0	159.0	30.0	145.0	2.0	5.11	0.05	0.00	0.00	0.0010	1.00	0.0050	1.56	20.22	7.57	2.80	0.25	170.0
Sep	29.80	47.00	Muddy	1000.3	7.24	215.0	160.0	35.0	143.0	3.2	5.15	0.10	0.01	0.01	0.0100	1.20	0.0033	2.00	19.32	6.38	2.60	0.28	120.0
Oct	28.35	20.00	Muddy Green	100.2	7.16	218.0	165.0	38.0	147.0	3.8	5.20	0.13	0.01	0.03	0.0110	1.32	0.0035	2.03	19.32	6.25	3.10	0.21	98.0
Nov	26.30	17.00	Greenish	29.0	7.18	229.0	178.0	41.0	149.0	5.0	5.35	0.11	0.00	0.04	0.0125	1.28	0.0020	2.04	19.31	6.20	2.30	0.10	92.0
Dec	21.20	14.00	Greenish	15.0	7.18	221.0	170.0	39.0	144.0	3.3	5.38	0.12	0.00	0.03	0.0120	1.17	0.0019	2.05	18.00	6.00	2.00	0.18	67.0

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-1

Year : 2005

Parameter	W.T. (^0C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.719	1																				
W.C.	0.381	0.693	1																			
pH	0.527	0.015	0.005	1																		
T.A.	0.296	-0.000	-0.026	0.045	1																	
T.H.	0.176	0.015	-0.041	0.043	0.054	1																
CaH	0.260	-0.001	-0.058	0.088	0.110	0.097	1															
MgH	0.667	-0.012	-0.006	0.024	0.025	0.021	0.030	1														
Cl.	0.558	0.027	-0.187	0.221	0.289	0.285	0.238	0.298	1													
D.O.	-0.851	-0.230	-0.011	0.019	-0.012	-0.003	-0.100	-0.019	-0.013	1												
B.O.D.	0.391	-0.169	-0.360	0.922	-0.952	0.696	0.746	0.771	0.674	-0.604	1											
C.O.D.	0.524	0.012	-0.003	0.024	0.023	0.016	0.027	0.028	0.022	-0.025	0.028	1										
NH_4-N	0.113	-0.020	-0.056	0.049	0.073	0.044	0.074	0.058	0.049	0.024	0.064	0.038	1									
NO_2-N	-0.528	-0.048	-0.047	-0.019	-0.014	0.023	0.046	0.003	-0.017	0.048	-0.017	0.046	0.009	1								
NO_3-N	0.283	-0.027	-0.075	0.071	0.094	0.084	0.062	0.056	0.092	0.031	0.089	0.065	-0.074	0.003	1							
PO_4	0.770	0.006	0.004	0.002	-0.001	-0.001	0.001	-0.004	-0.001	-0.006	-0.001	0.003	-0.000	0.002	-0.002	1						
SO_4	0.163	0.010	-0.060	0.064	0.091	0.055	-0.082	0.064	0.077	0.042	0.090	0.073	0.094	0.023	0.089	-0.011	1					
Na.	0.653	0.072	-0.042	0.066	0.028	0.006	0.027	0.040	0.065	-0.094	0.026	0.022	0.019	0.196	0.050	0.064	-0.001	1				
K	0.787	0.086	-0.054	0.053	0.016	0.002	0.011	0.045	0.042	-0.089	0.023	0.001	0.003	0.113	0.010	0.082	0.012	0.119	1			
Free CO_2	0.001	0.188	0.076	0.219	0.150	0.060	0.161	0.222	0.111	0.266	0.184	0.180	0.134	0.105	0.087	0.236	0.106	0.145	0.185	1		
F	0.062	0.275	0.576	0.040	-0.340	-0.234	-3.000	-0.350	0.498	-0.045	-0.203	0.028	0.565	0.075	-0.380	-0.280	-0.522	0.011	0.049	0.111	1	
MPN	0.201	0.266	0.226	0.035	0.057	-0.129	-0.062	0.064	0.009	-0.212	-0.020	0.009	0.067	0.146	0.105	0.249	-0.073	0.146	0.221	0.166	0.037	1

Table-5

Statistical Values of Mandakini River

Station No.-1

Parameter	Year : 2005				Year : 2006				Total			
	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
W.T.	26.93	4.15	32.15	19.04	25.78	4.85	33.18	17.08	26.36	4.50	32.67	18.06
Turbidity	28.58	13.88	55.00	14.00	31.46	16.61	62.00	15.10	30.02	15.25	58.50	14.55
Water current	208.78	362.78	1000.90	9.10	209.11	362.82	1000.80	7.00	208.95	362.80	1000.85	8.05
pH	7.30	0.31	8.30	7.00	7.31	0.31	8.33	7.10	7.31	0.31	8.32	7.05
T.A.	225.25	11.52	259.00	210.00	226.50	11.29	2.60	213.00	225.88	11.41	130.80	211.50
T.H.	172.83	11.94	198.00	159.00	159.58	45.34	199.00	150.00	166.21	28.64	198.50	154.50
CaH	37.37	5.41	50.00	30.00	38.42	6.59	55.00	30.00	37.90	6.00	52.50	30.00
MgH	146.58	5.27	158.00	138.00	147.17	5.58	159.00	139.00	146.88	5.43	158.50	138.50
Cl	5.02	2.20	9.00	2.00	5.39	2.37	9.10	2.20	5.21	2.29	9.05	2.10
D.O.	5.22	0.14	5.40	4.94	5.56	0.49	5.89	4.11	5.39	0.32	5.65	4.53
B.O.D.	0.18	0.12	0.55	0.05	0.21	0.17	0.75	0.08	0.20	0.15	0.65	0.07
C.O.D.	0.01	0.01	0.02	0.00	0.01	0.01	0.03	0.00	0.01	0.01	0.03	0.00
NH_4-N	0.03	0.01	0.05	0.00	0.04	0.05	0.06	0.00	0.04	0.03	0.06	0.00
NO_2-N	0.0128	0.0051	0.0250	0.0010	0.0157	0.0104	0.0270	0.0010	0.0143	0.0078	0.0260	0.0010
NO_3-N	1.29	0.13	1.54	1.00	1.32	0.14	1.62	0.02	1.31	0.14	1.58	0.51
PO_4	0.0027	0.0012	0.0050	0.0007	0.0036	0.0022	0.0059	0.0040	0.0032	0.0017	0.0055	0.0024
SO_4	2.08	0.22	2.50	1.56	2.07	0.24	2.70	1.55	2.08	0.23	2.60	1.56
Na	18.35	3.76	20.22	6.00	17.96	4.07	40.00	29.00	18.16	3.92	30.11	17.50
K	6.32	0.82	7.57	4.00	6.56	0.60	38.12	25.00	6.44	0.71	22.85	14.50
Free CO_2	2.42	0.70	4.00	1.40	2.62	0.63	4.80	1.80	2.52	0.67	4.40	1.60
F	0.17	0.06	0.28	0.10	0.26	0.27	0.49	0.16	0.22	0.17	0.39	0.13
MPN	100.08	31.06	170.00	58.00	106.33	36.44	1789.00	89.00	103.21	33.75	979.50	73.50

Table-6
Physico-Chemical Characteristics of Mandankini River

Station No.-2

Year : 2005

Month	W.T. (^0C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/Lt.)	MPN (Org/ Lt.)
Jan	20.00	20.00	Green	10.4	7.86	221.0	164.0	49.0	144.0	3.0	7.95	0.55	2.98	0.015	0.001	1.23	0.0118	2.08	9.81	1.50	1.60	0.18	60.0
Feb	23.00	27.00	Green	14.5	8.01	232.0	189.0	40.0	142.0	3.4	7.70	0.58	2.10	0.015	0.003	1.25	0.011	2.07	11.00	2.21	2.20	0.18	82.0
Mar	25.02	29.00	Greenish	20.1	8.04	234.0	178.0	42.0	141.0	5.3	7.50	0.62	2.78	0.017	0.004	1.28	0.046	2.05	11.22	2.28	2.40	0.30	121.0
Apr	28.03	32.00	Greenish	12.8	8.00	248.0	200.0	51.0	148.0	5.9	7.25	0.79	3.35	0.019	0.005	1.33	0.013	2.09	11.26	2.70	3.00	0.18	148.0
May	30.06	51.00	Green	8.7	8.30	270.0	204.0	52.0	152.0	7.1	7.10	0.80	3.62	0.020	0.006	1.37	0.0135	2.10	11.35	2.80	3.40	0.26	161.0
Jun	32.01	54.00	Green	7.0	8.50	278.0	218.0	59.0	160.0	6.1	5.10	1.50	4.94	0.052	0.026	1.57	0.0138	2.52	11.80	2.90	4.20	0.29	178.0
Jul	29.00	60.00	Dirty	400.0	8.00	262.0	160.0	50.0	158.0	5.1	6.00	0.90	2.98	0.040	0.007	1.30	0.0142	0.42	12.10	3.10	3.60	0.10	180.0
Aug	26.04	68.00	Muddy	1004.0	8.20	221.0	175.0	38.0	140.0	2.1	6.50	0.15	2.10	0.000	0.000	1.00	0.0192	1.58	13.28	3.68	3.40	0.32	200.0
Sep	29.34	61.00	Muddy	1000.0	8.20	225.0	185.0	41.0	146.0	3.2	6.68	0.22	5.34	0.015	0.002	1.15	0.0133	2.00	11.11	2.77	3.20	0.41	195.0
Oct	26.08	33.00	Muddy Green	100.3	8.10	233.0	192.0	45.0	149.0	3.8	7.25	0.32	2.99	0.030	0.003	1.32	0.0139	2.04	11.21	7.60	3.70	0.35	170.0
Nov	23.06	22.00	Greenish	30.6	8.00	234.0	198.0	48.0	150.0	5.3	7.70	0.28	2.77	0.042	0.004	1.30	0.0125	2.06	11.90	2.35	3.20	0.17	108.0
Dec	18.30	18.00	Green	15.0	7.90	227.0	168.0	46.0	145.0	3.2	7.85	0.52	2.78	0.030	0.003	1.20	0.0119	2.08	10.16	2.11	3.10	0.29	79.0

Table-7

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-2

Year : 2005

Parameter	W.T. (^{0}C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.309	1																				
W.C.	0.236	0.638	1																			
pH	0.018	0.015	0.005	1																		
T.A.	0.056	0.028	-0.026	0.047	1																	
T.H.	0.050	0.008	-0.026	0.063	0.050	1																
CaH	0.048	-0.000	-0.065	0.042	0.098	0.058	1															
MgH	0.025	-0.013	-0.009	0.019	0.035	0.017	0.034	1														
Cl.	0.182	0.012	-0.170	0.125	0.273	0.198	0.234	0.209	1													
D.O.	-0.095	-0.094	-0.042	-0.091	-0.076	-0.037	-0.050	-0.079	-0.032	1												
B.O.D.	0.301	-0.080	-0.303	0.282	-0.543	0.259	0.519	0.450	0.417	-0.367	1											
C.O.D.	0.186	0.120	-0.059	0.180	0.123	0.134	0.135	0.152	0.095	-0.162	-0.113	1										
NH_4-N	0.195	-0.083	-0.387	0.193	0.528	0.303	0.630	0.729	0.447	0.354	-0.512	0.289	1									
NO_2-N	0.023	-0.010	-0.012	-0.028	-0.032	0.024	0.031	0.031	-0.022	0.030	0.035	0.022	0.029	1								
NO_3-N	-0.052	-0.013	-0.078	0.049	0.095	0.076	0.099	0.089	0.092	-0.044	-0.097	-0.050	-0.089	0.096	1							
PO_4	0.001	0.002	-0.001	0.000	-0.006	-0.009	-0.018	-0.021	-0.008	-0.004	-0.002	0.010	0.014	-0.004	-0.004	1						
SO_4	0.031	0.112	-0.105	0.073	0.170	0.171	0.042	0.053	0.031	0.065	0.023	-0.077	0.003	-0.066	0.083	-0.001	1					
Na.	0.041	0.054	-0.040	0.038	0.018	0.015	0.009	0.014	0.007	-0.045	-0.003	0.007	0.000	-0.013	0.010	0.010	-0.030	1				
K	0.123	0.094	-0.062	0.106	0.004	0.079	0.048	0.068	0.043	-0.086	-0.096	0.010	0.043	0.013	0.024	0.031	0.036	0.127	1			
Free CO_2	0.151	0.135	-0.051	0.156	0.132	0.105	-0.088	0.155	0.079	0.169	0.070	0.095	-0.124	-0.128	0.082	0.045	0.030	0.134	0.117	1		
F	0.128	0.206	0.319	0.330	-0.180	-0.134	-0.239	-0.190	0.203	-0.099	-0.216	-0.308	0.186	-0.013	-0.155	-0.164	-0.305	0.023	0.282	0.202	1	
MPN	0.266	0.283	0.201	0.219	0.119	-0.087	-0.015	0.121	0.052	-0.242	-0.025	0.143	0.010	0.085	0.006	0.010	-0.095	0.228	0.158	0.241	0.131	1

Table-8

Statistical Values of Mandakini River

Station No.-2

Parameter	Year : 2005				Year : 2006				Total			
	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
W.T.	25.83	3.98	32.01	18.30	25.09	4.77	33.11	17.00	50.92	8.75	65.12	35.30
Turbidity	39.58	17.20	68.00	18.00	41.83	18.64	78.00	19.00	81.41	35.84	146.00	37.00
Water current	219.12	365.66	1004.00	7.00	220.96	368.04	1016.00	8.10	440.08	733.70	2020.00	15.10
pH	8.09	0.17	8.50	7.86	8.15	0.20	8.60	8.00	16.24	0.37	17.10	15.86
T.A.	240.42	18.69	278.00	221.00	242.92	18.97	279.00	220.00	483.34	37.66	557.00	441.00
T.H.	185.92	16.84	218.00	164.00	185.50	21.15	225.00	161.00	371.42	37.99	443.00	325.00
CaH	46.75	5.73	59.00	38.00	47.25	7.28	65.00	35.00	94.00	13.01	124.00	73.00
MgH	147.92	6.08	160.00	141.00	149.33	10.68	178.00	139.00	297.25	16.76	338.00	280.00
Cl	4.46	1.47	7.10	2.10	5.02	1.61	8.00	2.00	9.48	3.08	15.10	4.10
D.O.	7.05	0.81	7.95	5.10	7.10	0.75	7.90	5.30	14.15	1.56	15.85	10.40
B.O.D.	0.60	0.36	1.50	0.15	0.59	0.28	1.10	0.17	1.19	0.64	2.60	0.32
C.O.D.	3.23	0.95	5.34	2.10	3.04	0.79	5.10	2.11	6.27	1.74	10.44	4.21
NH_4-N	0.25	0.14	0.05	0.00	0.03	0.09	0.06	0.01	0.28	0.23	0.11	0.01
NO_2-N	0.005	0.007	0.026	0.001	0.006	0.021	0.038	0.000	0.011	0.028	0.064	0.001
NO_3-N	1.28	0.13	1.57	1.00	1.30	0.12	1.59	1.09	2.58	0.25	3.16	2.09
PO_4	0.0162	0.0092	0.0192	0.0110	0.0136	0.0474	0.0199	0.0113	0.0298	0.0566	0.0391	0.0223
SO_4	1.92	0.49	2.52	0.42	2.16	0.33	3.00	1.60	4.08	0.82	5.52	2.02
Na	11.35	0.86	13.28	10.16	11.56	1.04	11.90	9.79	22.91	1.90	25.18	19.95
K	3.00	1.48	3.68	1.50	2.73	0.63	4.40	1.70	5.73	2.11	8.08	3.20
Free CO_2	3.08	0.68	4.20	1.60	3.58	1.07	5.80	1.80	6.66	1.75	10.00	3.40
F	0.25	0.09	0.41	0.10	0.29	0.10	0.43	0.11	0.54	0.19	0.84	0.21
MPN	140.17	46.50	200.00	60.00	151.08	525.57	260.00	70.00	291.25	572.07	460.00	130.00

Table-9
Physico-Chemical Characteristics of Mandankini River

Station No.-3

Year : 2005

Month	W.T. (^{0}C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm. /Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org/ Lt)
Jan	18.04	28.00	Green	10.3	7.89	220.0	166.0	42.0	143.0	3.1	7.90	0.49	10.40	0.020	0.001	1.40	0.0335	2.15	21.00	8.00	1.50	0.38	65.0
Feb	21.00	30.00	Green	14.6	8.04	223.0	188.0	38.0	141.0	3.8	7.69	0.51	7.12	0.020	0.003	1.44	0.0202	2.13	23.00	9.10	2.30	0.21	92.0
Mar	23.06	36.00	Greenish	20.3	8.06	235.0	177.0	40.2	140.0	5.5	7.52	0.63	8.60	0.020	0.004	1.49	0.0334	2.11	23.40	9.30	2.60	0.40	131.0
Apr	27.03	39.00	Greenish	12.9	8.08	247.0	202.0	42.5	149.0	5.10	7.51	0.79	10.60	0.020	0.005	1.60	0.0345	2.18	24.00	9.50	3.00	0.21	149.0
May	30.35	42.00	Green	8.9	8.31	271.0	210.0	43.0	161.0	7.8	7.10	0.90	10.90	0.020	0.006	1.79	0.0351	2.20	25.90	9.55	3.40	0.30	168.0
Jun	33.05	56.00	Green	7.8	8.61	272.0	220.0	55.0	170.0	6.1	5.10	1.00	10.70	0.050	0.025	1.82	0.0358	2.55	26.40	9.60	4.40	0.39	179.0
Jul	28.10	61.00	Dirty	400.2	8.07	265.0	170.0	50.0	166.0	5.2	6.20	0.80	10.40	0.040	0.004	1.70	0.0367	2.49	27.10	9.80	3.70	0.11	189.0
Aug	27.30	72.00	Muddy	1005.0	8.05	218.0	157.0	25.0	139.0	2.2	6.72	0.18	7.19	0.00	0.000	1.05	0.0484	1.61	30.00	10.10	3.60	0.42	220.0
Sep	28.37	69.00	Muddy	1000.2	8.05	226.0	186.0	32.0	148.0	3.2	6.66	0.21	10.60	0.015	0.002	1.41	0.0353	2.06	23.30	9.50	3.30	0.49	220.0
Oct	26.07	38.00	Muddy Green	100.5	8.02	235.0	194.0	39.0	150.0	3.9	6.80	0.31	10.40	0.030	0.003	1.43	0.0355	2.11	23.40	9.20	3.80	0.39	185.0
Nov	24.20	29.00	Greenish	32.4	8.03	236.0	199.0	41.0	152.0	4.10	7.61	0.29	8.70	0.040	0.004	1.35	0.0338	2.12	23.20	9.10	3.10	0.18	150.0
Dec	19.11	20.00	Green	16.0	7.05	228.0	169.0	40.0	146.0	5.4	7.86	0.47	8.90	0.030	0.003	1.31	0.0337	2.14	22.50	8.90	3.00	0.39	88.0

Table-10

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-3 | Year : 2005

Parameter	W.T. (^{0}C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.254	1																				
W.C.	0.254	0.712	1																			
pH	0.032	0.022	0.002	1																		
T.A.	0.056	0.015	-0.025	0.043	1																	
T.H.	0.058	0.007	-0.043	0.059	0.064	1																
CaH	0.047	-0.037	-0.114	0.056	0.138	0.094	1															
MgH	0.046	-0.018	-0.012	0.032	0.060	0.039	0.051	1														
Cl.	0.116	0.068	-0.177	0.061	0.257	0.182	0.209	0.195	1													
D.O.	-0.095	-0.082	-0.035	-0.071	-0.068	-0.041	-0.045	-0.082	-0.021	1												
B.O.D.	0.232	-0.033	-0.309	0.240	-0.485	0.299	0.472	0.387	0.472	-0.205	1											
C.O.D.	0.062	0.017	-0.022	0.040	0.085	0.065	0.078	0.090	0.062	-0.051	0.067	1										
NH_4-N	0.020	-0.019	-0.047	0.014	0.054	0.045	0.077	0.067	0.041	0.038	0.043	0.035	1									
NO_2-N	-0.023	-0.006	-0.012	-0.021	-0.026	0.027	0.028	0.027	0.020	0.028	-0.026	0.014	0.026	1								
NO_3-N	0.084	-0.004	-0.073	0.086	0.141	0.109	0.132	0.126	0.126	-0.072	0.141	0.107	-0.091	0.102	1							
PO_4	0.018	0.027	0.026	0.004	-0.003	-0.103	-0.013	-0.004	-0.008	-0.017	-0.008	0.004	0.011	-0.001	-0.012	1						
SO_4	0.031	-0.014	-0.058	0.031	0.082	0.057	0.106	0.088	0.069	0.047	0.084	0.066	0.093	-0.073	0.095	-0.043	1					
Na.	0.065	0.073	-0.049	0.041	0.036	0.005	0.009	0.032	0.005	-0.061	0.015	-0.014	0.013	-0.021	0.003	0.066	-0.015	1				
K	0.043	0.042	-0.029	0.023	0.022	0.008	0.006	0.018	0.009	-0.034	0.008	-0.004	0.005	0.012	0.007	0.027	0.005	0.047	1			
Free CO_2	0.200	0.140	0.065	0.093	0.141	0.100	0.054	0.157	0.070	0.197	0.051	0.063	-0.092	-0.131	0.073	0.115	0.056	0.159	0.183	1		
F	0.001	0.129	0.217	0.063	-0.215	-0.094	0.246	-0.191	-0.140	-0.072	-0.210	0.025	0.220	-0.024	-0.195	-0.199	-0.231	0.038	0.052	0.028	1	
MPN	0.251	0.264	0.211	0.149	0.091	-0.051	0.061	0.108	-0.022	-0.210	-0.036	0.061	0.023	0.044	0.016	0.194	-0.041	0.215	0.253	0.240	0.047	1

Table-11

Statistical Values of Mandakini River

Station No.-3

Parameter	Year : 2005				Year : 2006				Total			
	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
W.T.	25.47	4.34	33.05	18.04	26.01	4.13	33.65	19.10	25.74	4.24	33.35	18.57
Turbidity	43.33	16.38	72.00	20.00	45.50	18.79	84.00	19.00	44.42	17.59	78.00	19.50
Water current	219.01	365.95	1005.00	7.80	220.12	366.12	1008.00	8.00	219.57	366.04	1006.50	7.90
pH	8.02	0.34	8.61	7.05	8.07	0.36	8.70	7.09	8.05	0.35	8.66	7.07
T.A.	229.67	18.79	272.00	218.00	243.33	20.06	282.00	215.00	236.50	19.43	277.00	216.50
T.H.	186.50	18.46	220.00	157.00	188.83	22.49	240.00	158.00	187.67	20.48	230.00	157.50
CaH	40.64	7.27	55.00	25.00	42.70	8.76	65.00	28.00	41.67	8.02	60.00	26.50
MgH	150.42	9.79	170.00	140.00	143.33	41.83	190.00	138.00	146.88	25.81	180.00	139.00
Cl	4.62	1.47	7.80	2.20	4.54	1.67	6.80	2.10	4.58	1.57	7.30	2.15
D.O.	7.06	0.78	7.90	5.10	6.96	0.80	7.80	5.00	7.01	0.79	7.85	5.05
B.O.D.	0.55	0.26	1.00	0.18	0.65	0.46	3.00	0.19	0.60	0.36	2.00	0.19
C.O.D.	9.54	1.32	10.90	7.12	9.61	1.35	10.90	7.14	9.58	1.34	10.90	7.13
NH_4-N	0.03	0.01	0.05	0.00	0.03	0.09	0.06	0.00	0.03	0.05	0.05	0.00
NO_2-N	0.005	0.006	0.025	0.000	0.006	0.021	0.035	0.000	0.006	0.014	0.030	0.000
NO_3-N	1.48	0.21	1.82	1.05	1.51	0.24	1.98	1.08	1.50	0.23	1.90	1.07
PO_4	0.0347	0.0058	0.0484	0.0202	0.0348	0.1214	0.0485	0.0204	0.0348	0.0636	0.0485	0.0203
SO_4	2.15	0.22	2.55	1.61	2.26	0.38	3.10	1.62	2.21	0.30	2.83	1.62
Na	24.43	2.36	30.00	21.00	25.54	4.47	39.50	22.00	24.99	3.42	34.75	21.50
K	9.30	0.51	10.10	8.00	9.34	0.88	11.00	7.00	9.32	0.70	10.55	7.50
Free CO_2	3.14	0.73	4.40	1.50	3.37	11.71	5.40	1.80	3.26	6.22	4.90	1.65
F	0.32	0.11	0.49	0.11	0.33	1.16	0.50	0.12	0.33	0.64	0.50	0.12
MPN	153.10	48.65	220.00	65.00	155.08	539.45	260.00	69.00	154.09	294.05	240.00	67.00

Table-12
Physico-Chemical Characteristics of Mandankini River

Station No.-4 Year : 2005

Month	W.T. (^{0}C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm. /Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
Jan	19.02	32.00	Green	10.2	7.90	221.0	167.0	43.0	154.0	3.10	6.90	0.51	10.77	0.020	0.001	1.50	0.0409	2.16	30.10	26.00	1.70	0.39	78.0
Feb	21.03	39.00	Green	15.4	8.05	234.0	190.0	37.0	152.0	4.50	6.68	0.58	7.15	0.020	0.002	1.54	0.0300	2.13	32.12	28.10	2.10	0.23	99.0
Mar	24.04	42.00	Greenish	20.0	8.07	236.0	178.0	40.4	150.0	5.90	6.53	0.64	9.80	0.020	0.004	1.59	0.0405	2.11	33.10	28.38	2.50	0.42	142.0
Apr	30.32	43.00	Greenish	12.1	8.09	249.0	210.0	43.10	169.0	7.10	6.52	0.80	13.60	0.020	0.004	1.78	0.0410	2.21	34.20	28.42	3.10	0.23	152.0
May	31.34	60.00	Green	8.6	8.34	276.0	220.0	44.0	176.0	8.00	6.10	0.90	14.10	0.020	0.005	1.86	0.0411	2.24	34.95	28.45	3.50	0.34	173.0
Jun	31.34	66.00	Green	7.8	8.71	278.0	230.0	60.0	180.0	6.15	4.10	1.00	13.30	0.052	0.020	1.90	0.0418	3.10	35.80	28.48	4.30	0.42	250.0
Jul	28.12	79.00	Dirty	400.4	8.08	269.0	175.0	53.0	178.0	5.80	5.20	0.89	13.10	0.039	0.004	1.80	0.0488	2.55	36.11	28.51	3.90	0.15	825.0
Aug	26.79	76.00	Muddy	1000.6	8.06	219.0	150.0	20.0	149.0	2.40	5.73	0.18	9.28	0.00	0.000	1.09	0.0415	1.51	39.13	30.12	3.60	0.44	1600.0
Sep	28.36	70.00	Muddy	1000.3	8.01	228.0	189.0	33.0	158.0	3.40	5.67	0.22	13.10	0.016	0.002	1.51	0.0417	2.07	32.30	28.42	3.20	0.48	245.0
Oct	27.11	43.00	Muddy Green	100.2	8.00	229.0	195.0	38.0	160.0	4.60	5.72	0.45	11.78	0.030	0.003	1.53	0.0430	2.12	32.40	28.30	3.80	0.41	114.0
Nov	23.09	32.00	Greenish	30.0	8.04	233.0	199.0	42.0	162.0	4.90	5.68	0.40	9.90	0.038	0.004	1.45	0.0425	2.14	32.20	28.20	3.20	0.19	105.0
Dec	21.11	26.00	Green	15.1	7.04	229.0	168.0	40.0	155.0	3.60	6.10	0.50	10.11	0.030	0.003	1.41	0.0411	2.15	31.12	27.00	3.10	0.41	90.0

Table-13

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-4

Year : 2005

Parameter	W.T. (^{0}C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.229	1																				
W.C.	0.192	0.595	1																			
pH	0.029	0.024	0.000	1																		
T.A.	0.058	0.036	-0.026	0.049	1																	
T.H.	0.072	0.004	-0.053	0.073	0.083	1																
CaH	0.060	0.000	-0.134	0.081	0.172	0.137	1															
MgH	0.048	-0.028	-0.015	0.035	0.061	0.047	0.052	1														
Cl.	0.194	0.026	-0.170	0.160	0.264	0.245	0.198	0.232	1													
D.O.	-0.073	-0.074	-0.028	-0.058	-0.067	-0.048	-0.056	-0.078	-0.016	1												
B.O.D.	0.231	-0.062	-0.310	0.234	-0.465	0.325	0.442	0.409	0.432	-0.141	1											
C.O.D.	0.144	0.081	-0.007	0.070	0.119	0.101	0.090	0.144	0.103	-0.077	0.092	1										
NH_4-N	0.014	-0.007	-0.046	0.020	0.052	0.048	0.079	0.059	0.034	0.057	0.053	0.028	1									
NO_2-N	-0.015	-0.007	-0.010	-0.018	-0.021	0.021	0.023	0.020	-0.014	0.023	-0.020	0.012	0.022	1								
NO_3-N	0.084	-0.024	-0.076	0.079	0.134	0.119	0.131	0.128	0.131	-0.044	0.139	0.104	-0.091	0.095	1							
PO_4	0.013	0.013	0.007	0.001	-0.009	0.002	-0.009	-0.015	-0.004	-0.015	-0.005	0.020	0.010	-0.004	-0.006	1						
SO_4	0.060	0.021	-0.078	0.075	0.130	0.112	0.161	0.130	0.089	0.102	0.134	0.083	0.147	-0.146	0.139	-0.036	1					
Na.	0.046	0.058	-0.034	0.035	0.029	0.001	0.007	0.024	0.013	-0.036	0.013	0.016	0.010	-0.017	0.002	0.022	-0.001	1				
K	0.020	0.023	-0.180	0.015	0.006	0.002	0.011	0.004	0.005	-0.014	-0.003	0.002	0.008	0.003	0.004	0.004	0.007	0.028	1			
Free CO_2	0.182	0.145	0.058	0.083	0.129	0.087	0.063	0.152	0.069	0.203	0.063	0.132	-0.100	-0.124	0.064	0.139	0.088	0.151	0.140	1		
F	0.017	0.048	0.178	0.045	-0.168	-0.087	-0.179	-0.194	0.213	-0.044	-0.201	0.017	0.160	-0.043	-0.170	-0.019	-0.098	-0.016	0.000	0.018	1	
MPN	0.179	0.558	0.574	0.091	0.061	-0.412	-0.350	0.064	0.271	-0.223	0.214	-0.072	0.318	0.146	0.358	0.243	-0.305	0.665	0.547	0.298	0.049	1

Table-14

Statistical Values of Mandakini River

Station No.-4

Parameter	Year : 2005				Year : 2006				Total			
	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
W.T.	25.97	4.05	31.34	19.02	26.31	4.51	33.40	19.35	26.14	4.28	32.37	19.19
Turbidity	50.67	17.74	79.00	26.00	53.17	19.96	90.00	29.00	51.92	18.85	84.50	27.50
Water current	218.39	365.37	1000.60	10.20	218.81	365.20	1000.70	6.00	218.60	365.29	1000.65	8.10
pH	8.03	0.36	8.71	7.04	8.13	0.24	8.80	7.80	8.08	0.30	8.76	7.42
T.A.	241.75	20.24	278.00	219.00	240.75	17.98	279.00	220.00	241.25	19.11	278.50	219.50
T.H.	189.25	22.33	230.00	150.00	191.25	22.03	238.00	162.00	190.25	22.18	234.00	156.00
CaH	41.13	9.37	60.00	20.00	42.34	11.09	70.00	22.00	41.74	10.23	65.00	21.00
MgH	161.92	10.69	180.00	149.00	161.75	10.86	180.00	148.00	161.84	10.78	180.00	148.50
Cl	4.95	1.62	8.00	3.10	4.97	1.69	8.10	1.85	4.96	1.66	8.05	2.48
D.O.	5.91	0.73	6.90	4.10	5.83	0.97	6.88	3.00	5.87	0.85	6.89	3.55
B.O.D.	0.59	0.25	1.00	0.18	0.68	0.50	2.15	0.17	0.64	0.38	1.58	0.18
C.O.D.	11.33	2.06	14.10	7.15	11.29	2.09	14.00	7.16	11.31	2.08	14.05	7.16
NH_4-N	0.03	0.01	0.05	0.00	0.07	0.10	0.05	0.00	0.05	0.06	0.05	0.00
NO_2-N	0.004	0.005	0.005	0.000	0.004	0.005	0.020	0.001	0.004	0.005	0.013	0.001
NO_3-N	1.58	0.22	1.90	1.09	1.61	0.28	2.20	1.00	1.60	0.25	2.05	1.05
PO_4	0.0412	0.0040	0.0488	0.0300	0.0415	0.0033	0.0489	0.0330	0.0414	0.0037	0.0489	0.0315
SO_4	2.21	0.35	3.10	1.51	2.28	0.53	3.89	1.52	2.25	0.44	3.50	1.52
Na	33.63	2.41	39.13	30.10	33.73	2.77	40.00	29.00	33.68	2.59	39.57	29.55
K	28.20	0.93	30.12	26.00	28.69	3.04	38.12	25.00	28.45	1.99	34.12	25.50
Free CO_2	3.17	0.72	4.30	1.70	3.31	0.78	4.80	1.80	3.24	0.75	4.55	1.75
F	0.34	0.11	0.48	0.15	0.35	0.11	0.49	0.16	0.35	0.11	0.49	0.16
MPN	322.75	431.50	1600.00	78.00	356.33	487.42	1789.00	89.00	339.54	459.46	1694.50	83.50

Table-15

Physico-Chemical Characteristics of Mandankini River

Station No.-1

Year : 2006

Month	W.T. (°C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm./Sec.)	pH	T.A. (Mg/Lt.)	T.H. (Mg/Lt.)	CaH (Mg/Lt.)	MgH (Mg/Lt.)	Cl (Mg/Lt.)	D.O. (Mg/Lt.)	B.O.D. (Mg/Lt.)	C.O.D. (Mg/Lt.)	NH_4-N (Mg/Lt.)	NO_2-N (Mg/Lt.)	NO_3-N (Mg/Lt.)	PO_4 (Mg/Lt.)	SO_4 (Mg/Lt.)	Na. (Mg/Lt.)	K (Mg/Lt.)	Free CO_2 (Mg/Lt.)	F (Mg/Lt.)	MPN (Org./Lt.)
Jan	17.08	19.20	Green	8.2	7.17	222.0	173.0	41.0	146.0	3.10	5.89	0.15	0.00	0.202	0.0150	1.20	0.0018	2.07	7.11	5.50	1.60	0.18	55.0
Feb	20.10	18.00	Green	10.8	7.21	225.0	176.0	33.0	139.0	3.40	5.88	0.16	0.00	0.020	0.0128	1.38	0.0099	2.05	19.35	6.30	1.80	0.13	78.0
Mar	23.15	19.20	Greenish	15.4	7.26	226.0	171.0	31.0	139.0	7.80	5.86	0.17	0.02	0.020	0.0129	1.37	0.0017	2.04	19.55	6.35	2.01	0.23	91.0
Apr	28.11	21.00	Greenish	12.0	7.28	228.0	174.0	35.00	149.0	7.80	5.83	0.19	0.01	0.020	0.0133	1.40	0.0023	2.10	19.68	6.39	2.30	0.13	96.0
May	30.05	31.00	Green	7.8	7.29	230.0	193.0	44.0	153.0	9.10	5.80	0.22	0.00	0.030	0.0160	1.43	0.0031	2.10	19.73	6.90	2.85	0.16	98.0
Jun	33.18	45.00	Green	7.0	8.33	260.0	199.0	55.0	159.0	8.40	4.11	0.75	0.03	0.060	0.0270	1.62	0.0037	2.70	19.96	6.95	3.89	0.19	120.0
Jul	30.10	58.00	Dirty	300.2	7.27	232.0	155.0	41.0	151.0	7.10	5.13	0.26	0.01	0.040	0.0140	1.31	0.0041	2.09	19.98	6.99	2.95	0.00	160.0
Aug	28.15	62.00	Muddy	1000.8	7.23	213.0	150.0	30.0	146.0	2.20	5.45	0.08	0.00	0.00	0.0010	1.02	0.0059	1.55	21.11	8.10	2.91	0 .29	189.0
Sep	27.04	50.00	Muddy	1000.4	7.23	218.0	159.0	34.0	142.0	3.30	5.58	0.11	0.00	0.020	0.0100	1.22	0.0037	2.00	19.31	6.39	2.89	0.30	130.0
Oct	28.74	20.00	Muddy Green	100.7	7.18	220.0	166.0	37.0	148.0	3.90	5.63	0.14	0.00	0.030	0.0110	1.36	0.0022	2.03	19.31	6.35	3.20	0.22	99.0
Nov	25.30	19.00	Greenish	30.2	7.10	223.0	179.0	42.0	150.0	5.20	5.87	0.12	0.01	0.040	0.0126	1.29	0.0024	2.04	19.30	6.30	2.83	0.11	90.0
Dec	18.40	15.10	Green	16.0	7.20	221.0	170.0	38.0	144.0	3.40	5.71	0.13	0.00	0.030	0.0122	1.18	0.0019	2.06	11.13	6.25	2.16	0.19	70.0

Table-16

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-1

Year : 2006

Parameter	W.T. (^{0}C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.278	1																				
W.C.	0.198	0.677	1																			
pH	0.020	0.016	0.007	1																		
T.A.	0.051	0.017	-0.030	0.033	1																	
T.H.	0.059	-0.011	-0.051	0.058	0.071	1																
CaH	0.073	-0.003	-0.078	0.046	0.133	0.100	1															
MgH	0.042	0.022	-0.015	0.033	0.060	0.034	0.064	1														
Cl.	0.197	-0.033	-0.100	0.113	0.269	0.213	0.242	0.194	1													
D.O.	-0.085	-0.084	-0.040	-0.077	-0.062	-0.027	-0.056	-0.083	-0.041	1												
B.O.D.	0.236	0.001	-0.291	-0.097	-0.475	0.242	0.448	0.438	0.370	-0.240	1											
C.O.D.	0.183	0.069	-0.051	0.154	0.204	0.188	0.234	0.223	0.199	-0.179	0.165	1										
NH_4-N	0.215	-0.068	-0.352	0.223	0.537	0.393	0.647	0.618	0.428	0.378	0.433	0.483	1									
NO_2-N	-0.033	-0.013	-0.015	-0.041	-0.042	0.039	0.049	0.052	-0.031	0.044	-0.039	0.051	0.044	1								
NO_3-N	0.053	-0.011	-0.065	0.041	0.089	0.082	0.096	0.085	0.075	-0.047	0.082	0.086	0.081	0.086	1							
PO_4	0.006	0.013	0.011	-0.006	-0.000	-0.005	-0.003	-0.001	-0.003	-0.008	-0.003	0.000	-0.002	-0.000	-0.004	1						
SO_4	0.069	0.010	-0.063	0.051	0.130	0.081	0.143	0.150	0.103	0.101	0.136	0.123	0.132	-0.135	0.138	-0.031	1					
Na.	0.049	0.078	-0.068	0.048	0.004	0.011	0.018	0.003	0.004	-0.054	0.020	0.001	0.009	-0.007	0.019	0.080	-0.014	1				
K	0.134	0.207	-0.163	0.127	0.020	0.040	0.042	0.002	0.027	-0.143	0.036	0.001	0.029	0.018	0.045	0.229	0.039	0.224	1			
Free CO_2	0.222	0.193	0.044	0.192	0.213	0.090	0.176	0.230	0.134	0.259	0.144	0.176	0.185	-0.199	0.162	0.180	0.174	0.170	0.194	1		
F	0.144	0.241	0.293	-0.388	-0.172	-0.011	-0.089	-0.001	0.136	-0.185	-0.273	0.143	0.107	-0.139	-0.097	-0.183	-0.119	0.144	0.183	0.061	1	
MPN	0.252	0.315	0.246	0.209	0.061	-0.013	-0.130	0.073	0.027	-0.240	0.036	0.081	0.025	0.048	0.025	0.301	-0.018	0.299	0.313	0.225	0.137	1

Table-17
Physico-Chemical Characteristics of Mandankini River

Station No.-2 | Year : 2006

Month	W.T. (^0C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm. /Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
Jan	17.00	22.00	Green	11.4	7.80	228.0	166.0	47.0	147.0	3.50	7.90	0.56	2.99	0.014	0.001	1.25	0.0116	2.10	9.79	1.70	1.80	0.29	70.0
Feb	22.00	28.00	Green	15.6	8.10	234.0	199.0	40.0	141.0	3.80	7.75	0.61	2.11	0.016	0.003	1.27	0.0113	2.08	11.10	2.35	2.40	0.17	89.0
Mar	26.00	30.00	Greenish	21.4	8.20	238.0	177.0	44.0	140.0	5.50	7.55	0.64	2.79	0.018	0.004	1.29	0.0115	2.06	11.28	2.40	2.60	0.32	126.0
Apr	29.00	34.00	Greenish	13.8	8.00	249.0	200.0	52.00	149.0	5.90	7.23	0.79	3.40	0.020	0.004	1.35	0.0135	2.12	11.40	2.75	3.60	0.19	159.0
May	30.00	50.00	Green	9.9	8.30	275.0	210.0	53.0	155.0	8.00	7.20	0.83	3.71	0.026	0.006	1.39	0.0139	2.16	11.50	2.86	4.30	0.27	170.0
Jun	33.11	56.00	Green	8.1	8.60	279.0	225.0	65.0	178.0	7.00	5.30	1.10	5.10	0.060	0.038	1.59	0.0140	3.00	11.90	2.94	5.80	0.39	179.0
Jul	28.12	62.00	Dirty	408.0	8.00	265.0	161.0	51.0	162.0	6.00	6.20	0.95	2.99	0.040	0.005	1.32	0.0155	2.59	12.30	3.15	4.90	0.11	190.0
Aug	26.10	78.00	Muddy	1016.0	8.30	220.0	152.0	35.0	139.0	2.00	6.61	0.17	2.12	0.005	0.000	1.09	0.0199	1.60	14.10	4.40	4.32	0.41	260.0
Sep	28.75	64.00	Muddy	1000.0	8.30	226.0	186.0	42.0	145.0	5.50	6.68	0.24	3.35	0.015	0.002	1.17	0.0137	2.00	12.20	2.79	3.02	0.43	200.0
Oct	27.00	36.00	Muddy Green	100.5	8.20	236.0	192.0	45.0	148.0	3.90	7.26	0.35	2.98	0.032	0.003	1.34	0.0138	2.04	11.20	2.80	3.70	0.36	180.0
Nov	20.80	23.00	Greenish	32.8	8.00	238.0	195.0	48.0	142.0	5.40	7.72	0.29	2.78	0.044	0.004	1.31	0.0126	2.07	11.80	2.41	3.30	0.18	110.0
Dec	18.00	19.00	Green	14.0	7.98	227.0	163.0	45.0	146.0	3.70	7.83	0.54	2.19	0.034	0.002	1.22	0.0118	2.09	10.19	2.18	3.20	0.31	80.0

Table-18

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-2

Year : 2006

Parameter	W.T. (^0C)	TUR (N.T.U.)	W.C (Cu.Cm./ Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
W.T.	1																					
Tur	0.287	1																				
W.C.	0.206	0.657	1																			
pH	0.023	0.013	0.006	1																		
T.A.	0.024	0.007	-0.021	0.046	1																	
T.H.	0.012	0.031	-0.054	0.046	0.056	1																
CaH	0.066	-0.013	-0.072	0.123	0.140	0.123	1															
MgH	0.026	-0.012	-0.008	0.024	0.026	0.020	0.032	1														
Cl.	0.228	0.000	-0.196	0.193	0.284	0.247	0.203	0.225	1													
D.O.	-0.056	-0.052	-0.008	-0.082	-0.072	-0.024	-0.061	-0.060	-0.028	1												
B.O.D.	0.501	-0.234	-0.283	0.949	-0.951	0.622	0.792	0.684	0.552	-0.866	1											
C.O.D.	0.025	0.006	-0.018	0.044	0.047	0.027	0.030	0.026	0.039	-0.039	0.046	1										
NH_4-N	0.162	-0.086	-0.116	0.017	0.041	0.074	0.138	0.051	0.053	0.008	0.044	0.014	1									
NO_2-N	-0.046	-0.181	-0.417	-0.521	-0.558	0.595	0.400	0.247	-0.416	0.297	-0.529	0.405	0.105	1								
NO_3-N	0.055	-0.025	-0.077	0.083	0.105	0.098	0.078	0.062	0.096	-0.057	0.094	0.082	0.005	0.090	1							
PO_4	0.000	0.004	0.003	0.000	-0.001	-0.002	-0.003	-0.004	-0.004	-0.001	-0.009	0.003	-0.004	-0.002	-0.009	1						
SO_4	0.034	0.018	-0.070	0.098	0.113	0.095	0.102	0.071	0.073	0.078	0.108	0.086	0.031	-0.093	0.107	-0.022	1					
Na.	0.170	0.098	-0.065	0.046	0.042	0.006	0.022	0.040	0.086	-0.060	0.039	0.069	0.176	-0.020	0.072	0.079	-0.008	1				
K	0.060	0.072	-0.052	0.024	0.007	0.022	0.005	0.028	0.009	-0.041	0.016	0.010	0.054	0.011	0.015	0.033	0.027	0.060	1			
Free CO_2	0.219	0.144	0.064	0.151	0.124	0.044	0.136	0.181	0.076	0.188	0.145	0.099	-0.082	-0.009	0.088	0.017	0.089	0.142	0.141	1		
F	0.604	0.271	0.050	0.143	-0.202	-0.018	-0.191	-0.433	0.486	-0.273	-0.170	0.332	0.502	-0.085	-0.170	-0.382	-0.106	0.465	0.390	0.555	1	
MPN	0.214	0.302	0.245	0.055	0.002	-0.164	-0.039	0.075	0.004	-0.149	0.031	0.029	0.152	0.123	0.084	0.090	-0.104	0.202	0.288	0.191	0.142	1

Table-19
Physico-Chemical Characteristics of Mandankini River

Station No.-3 Year : 2006

Month	W.T. (^oC)	TUR (N.T.U.)	Colour	W.C (Cu.Cm /Sec.)	pH	T.A. (Mg/ Lt.)	T.H. (Mg/ Lt.)	CaH (Mg/ Lt.)	MgH (Mg/ Lt.)	Cl (Mg/ Lt.)	D.O. (Mg/ Lt.)	B.O.D. (Mg/ Lt.)	C.O.D. (Mg/ Lt.)	NH_4-N (Mg/ Lt.)	NO_2-N (Mg/ Lt.)	NO_3-N (Mg/ Lt.)	PO_4 (Mg/ Lt.)	SO_4 (Mg/ Lt.)	Na. (Mg/ Lt.)	K (Mg/ Lt.)	Free CO_2 (Mg/ Lt.)	F (Mg/ Lt.)	MPN (Org./ Lt.)
Jan	19.10	27.00	Green	11.13	7.90	215.0	164.0	43.0	142.0	3.30	7.80	0.50	10.5	0.020	0.002	1.39	0.0336	2.18	22.00	7.00	1.80	0.39	69.0
Feb	22.10	32.00	Green	15.8	8.12	232.0	189.0	39.0	140.0	3.70	7.60	0.59	7.14	0.021	0.004	1.44	0.0204	2.15	22.00	9.00	2.50	0.22	95.0
Mar	23.07	36.00	Greenish	22.7	8.15	236.0	178.0	40.4	140.0	5.80	7.50	0.65	8.70	0.022	0.005	1.48	0.0336	2.12	23.00	9.40	2.80	0.41	134.0
Apr	27.10	40.00	Greenish	14.8	8.17	249.0	204.0	42.10	150.0	5.48	7.48	0.80	10.70	0.020	0.005	1.70	0.0346	2.20	24.00	9.60	3.40	0.22	140.0
May	31.01	48.00	Green	9.0	8.40	273.0	215.0	44.5	164.0	8.10	7.00	0.90	10.90	0.020	0.006	1.79	0.0353	2.30	25.00	9.65	3.78	0.30	167.0
Jun	33.65	59.00	Green	8.0	8.70	282.0	240.0	65.0	190.0	6.80	5.00	2.00	10.80	0.055	0.035	1.98	0.0359	3.10	26.50	9.70	5.40	0.40	178.0
Jul	28.25	63.00	Dirty	400.4	8.08	270.0	172.0	53.0	180.0	5.10	6.10	0.82	10.50	0.042	0.005	1.72	0.0369	2.98	27.30	9.90	3.80	0.12	190.0
Aug	27.40	84.00	Muddy	1008.0	8.05	226.0	158.0	28.0	138.0	2.10	6.60	0.19	7.20	0.002	0.000	1.08	0.0485	1.62	39.50	11.00	3.10	0.43	260.0
Sep	28.45	70.00	Muddy	1000.4	8.06	229.0	189.0	34.4	149.0	3.30	6.50	0.25	10.70	0.014	0.002	1.42	0.0354	2.08	24.30	9.60	3.60	0.50	210.0
Oct	26.70	39.00	Muddy Green	100.6	8.03	238.0	192.0	40.0	152.0	3.15	6.70	0.33	10.50	0.029	0.003	1.43	0.0356	2.12	24.80	9.30	3.90	0.40	187.0
Nov	25.10	29.00	Greenish	32.6	8.04	240.0	198.0	42.0	154.0	4.20	7.51	0.30	8.80	0.039	0.004	1.32	0.0340	2.14	24.30	9.10	3.20	0.19	152.0
Dec	20.15	19.00	Green	18.0	7.09	230.0	167.0	41.0	147.0	3.50	7.76	0.48	8.90	0.029	0.003	1.33	0.0338	2.16	23.80	8.80	3.10	0.40	79.0

Station No.-3

Table-20

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Year : 2006

Parameter	W.T. (°C)	TUR (N.T.U.)	W.C (Cu.Cm./Sec.)	pH	T.A. (Mg/Lt.)	T.H. (Mg/Lt.)	CaH (Mg/Lt.)	MgH (Mg/Lt.)	Cl (Mg/Lt.)	D.O. (Mg/Lt.)	B.O.D. (Mg/Lt.)	C.O.D. (Mg/Lt.)	NH_4-N (Mg/Lt.)	NO_2-N (Mg/Lt.)	NO_3-N (Mg/Lt.)	PO_4 (Mg/Lt.)	SO_4 (Mg/Lt.)	Na. (Mg/Lt.)	K (Mg/Lt.)	Free CO_2 (Mg/Lt.)	F (Mg/Lt.)	MPN (Org./Lt.)
W.T.	1																					
Tur	0.262	1																				
W.C.	0.217	0.707	1																			
pH	0.033	0.020	0.001	1																		
T.A.	0.065	0.022	-0.021	0.050	1																	
T.H.	0.083	0.004	-0.044	0.083	0.086	1																
CaH	0.088	-0.014	-0.101	0.089	0.158	0.128	1															
MgH	0.074	-0.028	-0.016	0.051	0.092	0.065	0.090	1														
Cl.	0.192	0.015	-0.174	0.206	0.294	0.254	0.231	0.218	1													
D.O.	-0.097	-0.082	-0.038	-0.069	-0.078	-0.057	-0.067	-0.092	-0.032	1												
B.O.D.	0.387	-0.062	-0.282	0.411	-0.550	0.510	0.622	0.544	0.504	-0.431	1											
C.O.D.	0.063	0.007	-0.023	0.041	0.068	0.066	0.074	0.082	0.068	-0.051	0.057	1										
NH_4-N	0.029	-0.020	-0.047	0.022	0.061	0.051	0.085	0.077	0.041	0.046	0.064	0.035	1									
NO_2-N	-0.032	-0.008	-0.016	-0.032	-0.038	0.042	0.046	0.041	-0.030	0.039	-0.051	0.018	0.039	1								
NO_3-N	0.107	-0.009	-0.074	0.107	0.152	0.134	0.147	0.140	0.149	-0.091	0.151	0.116	-0.108	0.125	1							
PO_4	0.017	0.029	0.026	0.002	-0.003	-0.009	-0.007	-0.005	-0.006	-0.017	-0.005	0.004	0.009	-0.001	-0.009	1						
SO_4	0.084	0.011	-0.060	0.073	0.143	0.095	0.172	0.165	0.106	0.113	0.147	0.097	0.154	-0.132	0.151	-0.030	1					
Na.	0.063	0.132	-0.117	0.018	0.004	0.045	0.049	0.001	0.049	-0.070	0.021	0.061	0.055	-0.006	0.057	0.142	-0.043	1				
K	0.064	0.072	-0.052	0.032	0.038	0.015	0.011	0.022	0.011	-0.051	0.008	0.019	0.011	0.011	0.005	0.051	0.002	0.069	1			
Free CO_2	0.224	0.112	0.011	0.131	0.205	0.187	0.160	0.211	0.125	0.220	0.172	0.119	-0.153	-0.192	0.167	0.068	0.161	0.049	0.137	1		
F	0.011	0.120	0.211	0.069	-0.217	-0.062	-0.164	-0.164	0.157	-0.076	-0.060	0.019	0.201	-0.039	-0.163	-0.188	-0.202	0.097	0.012	0.023	1	
MPN	0.239	0.294	0.242	0.140	0.091	-0.035	-0.047	0.084	0.018	-0.216	-0.013	0.015	0.046	0.024	0.010	0.234	-0.015	0.248	0.274	0.173	0.056	1

Table-21

Physico-Chemical Characteristics of Mandankini River

Station No.-4

Year : 2006

Month	W.T. (^0C)	TUR (N.T.U.)	Colour	W.C (Cu.Cm./Sec.)	pH	T.A. (Mg/Lt.)	T.H. (Mg/Lt.)	CaH (Mg/Lt.)	MgH (Mg/Lt.)	Cl (Mg/Lt.)	D.O. (Mg/Lt.)	B.O.D. (Mg/Lt.)	C.O.D. (Mg/Lt.)	NH_4-N (Mg/Lt.)	NO_2-N (Mg/Lt.)	NO_3-N (Mg/Lt.)	PO_4 (Mg/Lt.)	SO_4 (Mg/Lt.)	Na. (Mg/Lt.)	K (Mg/Lt.)	Free CO (Mg/Lt.)	F (Mg/Lt.)	MPN (Org./Lt.)
Jan	19.35	33.00	Green	10.40	7.80	223.0	167.0	42.0	153.0	3.20	6.88	0.52	10.7	0.020	0.001	1.52	0.0408	2.17	29.00	25.00	1.80	0.38	89.0
Feb	21.04	39.00	Green	15.8	8.10	232.0	191.0	36.0	151.0	4.80	6.67	0.58	7.16	0.020	0.002	1.55	0.0330	2.14	31.00	26.20	2.20	0.24	100.0
Mar	24.04	41.00	Greenish	20.4	8.20	235.0	179.0	41.0	150.0	5.92	6.54	0.66	8.80	0.020	0.004	1.59	0.0406	2.12	33.10	28.38	2.60	0.41	152.0
Apr	30.40	44.00	Greenish	12.4	8.01	250.0	210.0	43.10	168.0	7.12	6.58	0.82	13.10	0.020	0.004	1.79	0.0409	2.23	34.30	28.43	3.20	0.24	154.0
May	32.50	62.00	Green	8.7	8.40	267.0	221.0	45.0	177.0	8.10	6.00	0.89	14.00	0.020	0.005	1.87	0.0412	2.25	35.00	28.46	3.60	0.35	178.0
Jun	33.40	67.00	Green	6.4	8.80	279.0	238.0	70.0	180.0	6.25	3.00	2.15	13.50	0.053	0.020	2.20	0.0419	3.89	35.98	28.49	4.80	0.43	265.0
Jul	29.10	90.00	Dirty	400.8	8.09	260.0	176.0	55.0	177.0	5.70	5.40	0.88	13.20	0.038	0.004	1.81	0.0489	2.56	36.20	28.61	3.50	0.16	950.0
Aug	26.00	80.00	Muddy	1000.7	8.07	220.0	162.0	22.0	148.0	1.85	5.72	0.17	9.38	0.000	0.001	1.00	0.0416	1.52	40.00	38.12	3.70	0.45	1789.0
Sep	28.50	76.00	Muddy	1000.2	8.05	229.0	188.0	34.0	157.0	3.60	5.65	0.20	13.20	0.017	0.002	1.52	0.0418	2.09	33.40	28.43	3.30	0.49	255.0
Oct	27.20	44.00	Muddy Green	100.5	8.04	230.0	196.0	39.0	161.0	4.80	5.79	0.44	11.72	0.029	0.003	1.54	0.0432	2.13	33.50	28.40	3.90	0.42	127.0
Nov	24.10	33.00	Greenish	34.0	8.06	234.0	198.0	41.0	163.0	4.90	5.63	0.39	10.80	0.037	0.004	1.48	0.0423	2.15	32.10	28.29	3.90	0.18	119.0
Dec	20.10	29.00	Green	15.4	7.98	230.0	169.0	40.0	156.0	3.50	6.09	0.49	9.90	0.031	0.003	1.50	0.0412	2.16	31.14	27.50	3.20	0.42	98.0

Table-22

Matrix Showing Correlation of Coefficient among various physico-chemical Parameters

Station No.-4 Year : 2006

Parameter	W.T. (^{0}C)	TUR (N.T.U.)	W.C (Cu.Cm./Sec.)	pH	T.A. (Mg/Lt.)	T.H. (Mg/Lt.)	CaH (Mg/Lt.)	MgH (Mg/Lt.)	Cl (Mg/Lt.)	D.O. (Mg/Lt.)	B.O.D. (Mg/Lt.)	C.O.D. (Mg/Lt.)	NH_4-N (Mg/Lt.)	NO_2-N (Mg/Lt.)	NO_3-N (Mg/Lt.)	PO_4 (Mg/Lt.)	SO_4 (Mg/Lt.)	Na. (Mg/Lt.)	K (Mg/Lt.)	Free CO_2 (Mg/Lt.)	F (Mg/Lt.)	MPN (Org./Lt.)
W.T.	1																					
Tur	0.225	1																				
W.C.	0.124	0.607	1																			
pH	0.021	0.010	0.005	1																		
T.A.	0.058	0.028	-0.025	0.060	1																	
T.H.	0.084	0.007	0.045	0.089	0.090	1																
CaH	0.124	-0.034	-0.125	0.170	0.217	0.162	1															
MgH	0.053	-0.026	-0.018	0.041	0.062	0.049	0.054	1														
Cl.	0.208	0.002	-0.188	0.177	0.265	0.253	0.197	0.240	1													
D.O.	-0.103	-0.081	-0.017	-0.135	-0.106	-0.095	-0.112	-0.103	-0.025	1												
B.O.D.	0.394	-0.123	-0.301	0.584	-0.605	0.508	0.635	0.502	0.402	-0.506	1											
C.O.D.	0.150	0.089	-0.014	0.068	0.123	0.105	0.099	0.153	0.093	-0.088	0.080	1										
NH_4-N	0.172	-0.275	-0.187	0.118	0.134	0.085	0.002	0.037	0.124	0.022	0.074	0.043	1									
NO_2-N	0.017	-0.006	-0.009	-0.027	-0.023	0.022	0.025	0.019	-0.013	0.026	-0.028	0.013	0.001	1								
NO_3-N	0.113	-0.019	-0.099	0.127	0.169	0.148	0.173	0.156	0.149	-0.096	0.163	0.115	-0.011	0.143	1							
PO_4	0.011	0.014	0.006	0.001	-0.008	-0.002	-0.009	-0.013	-0.002	-0.009	-0.003	0.017	0.004	-0.003	-0.004	1						
SO_4	0.122	0.040	-0.091	0.189	0.194	0.169	0.231	0.173	0.112	0.195	0.232	0.114	0.002	-0.230	0.212	-0.043	1					
Na.	0.054	0.065	-0.046	0.035	0.027	0.011	0.000	0.025	0.004	-0.040	0.016	0.026	0.020	-0.021	0.004	0.034	-0.005	1				
K	0.026	0.057	-0.071	0.010	0.017	0.024	0.046	0.019	0.038	-0.021	0.022	0.007	0.018	0.008	0.056	0.021	0.035	0.091	1			
Free CO_2	0.172	0.105	0.035	0.156	0.130	0.137	0.099	0.149	0.057	0.201	0.112	0.134	-0.046	-0.155	0.079	0.114	0.118	0.152	0.098	1		
F	0.009	0.046	0.146	0.082	-0.123	-0.047	-0.109	-0.168	0.200	-0.095	-0.024	0.001	0.132	-0.057	-0.103	-0.052	-0.012	0.061	0.136	0.051	1	
MPN	0.123	0.565	0.576	0.017	0.093	-0.325	-0.252	0.088	0.346	-0.138	0.144	0.049	0.215	0.112	0.382	0.278	-0.218	0.654	0.716	0.194	0.058	1

Monthly Variation in Abundance of Phytoplanktons

Station No-1 **Year : 2005**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	5	6	8	11	11	10	4	2	0	0	8	3
Chlorella	4	6	8	10	12	11	6	5	8	8	10	6
Cosmarium	5	4	4	5	6	0	0	0	3	4	2	3
Eudorina	2	2	0	0	0	1	2	4	0	0	0	2
Hydrodicton	4	4	5	4	0	0	0	3	4	4	5	5
Microspora	0	5	5	8	8	10	2	2	3	4	5	6
Mougeotia	9	8	8	10	14	9	0	0	2	4	6	7
Pandorina	4	4	6	10	14	11	0	0	0	0	10	6
Pediastrum	12	10	6	11	12	30	0	1	3	9	11	5
Spirogyra	8	7	9	10	8	7	0	0	5	7	3	8
Ulothrix	18	11	14	15	12	11	0	0	3	5	10	7
Zygnema	4	5	7	9	10	9	8	0	0	2	4	5
Total	**75**	**72**	**80**	**103**	**107**	**109**	**22**	**17**	**31**	**47**	**74**	**63**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	3	2	4	4	6	11	0	0	0	3	4	5
Coconies	5	6	5	8	8	10	7	0	0	4	6	5
Fragillaria	14	15	13	17	20	25	0	0	1	0	10	12
Gomphonema	7	7	8	6	9	10	8	0	0	0	5	6
Nitchia Palaea	3	4	4	5	8	12	6	3	2	4	5	3
Synedraacus	5	4	4	7	10	15	2	0	0	0	6	4
Tabelloeria	4	8	8	13	15	25	5	0	0	0	2	2
Pinnularia	2	2	2	3	4	6	0	0	0	1	2	0
Total	**43**	**48**	**48**	**63**	**80**	**114**	**28**	**3**	**3**	**12**	**40**	**37**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	4	4	5	7	6	9	2	1	2	2	2	3
Anabaena	0	1	4	4	7	10	2	2	3	4	5	6
Cylinderospernum	2	2	3	5	6	12	2	0	0	2	3	3
Rivularia	2	3	2	3	5	9	3	2	4	4	5	6
Microcoleus	15	17	16	18	20	29	15	5	6	7	12	10
Vaucharia	3	2	2	3	4	5	2	0	3	2	3	2
Phormidium	0	0	3	4	4	7	3	2	4	3	5	4
Total	**26**	**29**	**35**	**44**	**52**	**81**	**29**	**12**	**22**	**24**	**35**	**34**
Grand Total	**144**	**149**	**163**	**210**	**239**	**304**	**79**	**32**	**56**	**83**	**149**	**134**

Table-24

Monthly Variation in Abundance of Phytoplanktons

Station No-2 **Year : 2005**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	4	6	7	10	12	13	3	2	4	5	9	4
Chlorella	6	7	9	9	12	14	4	3	4	4	8	7
Cosmarium	6	5	5	6	10	12	0	0	0	4	5	4
Eudorina	1	3	3	0	0	0	2	2	4	6	5	3
Hydrodicton	4	5	5	4	4	7	0	0	3	2	4	5
Microspora	2	2	5	7	8	11	2	2	5	5	6	4
Mougeotia	10	9	9	12	15	8	0	0	0	4	5	6
Pandorina	4	5	7	12	12	13	5	4	6	8	10	6
Pediastrum	11	8	6	7	13	31	0	2	3	6	9	5
Spirogyra	18	18	17	16	20	25	5	4	3	8	7	9
Ulothrix	19	11	12	15	14	12	0	0	3	5	8	7
Zygnema	5	4	8	10	12	8	8	3	2	2	4	5
Total	**90**	**83**	**93**	**108**	**132**	**154**	**29**	**22**	**37**	**59**	**80**	**65**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	4	4	6	5	11	11	0	0	0	2	3	2
Coconies	0	0	0	4	5	6	2	2	1	2	2	0
Fragillaria	7	6	8	8	9	18	8	3	3	4	5	6
Gomphonema	3	4	5	8	11	17	4	3	2	3	5	4
Nitchia Palaea	11	4	4	6	16	4	1	2	9	14	13	14
Synedraacus	4	3	15	15	20	25	2	2	12	12	11	13
Tabellocria	2	4	6	7	6	15	4	1	2	4	6	8
Pinnularia	3	3	4	5	5	9	0	0	1	2	2	4
Total	**30**	**24**	**42**	**53**	**72**	**94**	**21**	**13**	**30**	**41**	**44**	**49**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	3	4	3	5	7	8	8	1	1	2	3	3
Anabaena	4	4	6	7	11	13	1	1	2	4	6	7
Cylinderospernum	0	0	3	4	7	15	0	0	0	2	1	3
Rivularia	2	1	2	2	3	4	0	0	7	1	2	2
Microcoleus	20	26	18	16	30	34	18	15	12	20	24	22
Vaucheria	1	2	2	3	4	6	0	0	2	2	3	4
Phormidium	1	2	0	0	2	4	0	0	1	0	2	3
Total	**31**	**39**	**34**	**37**	**64**	**84**	**27**	**17**	**25**	**31**	**41**	**44**
Grand Total	**151**	**146**	**169**	**198**	**268**	**332**	**77**	**52**	**92**	**131**	**165**	**158**

Table-25

Monthly Variation in Abundance of Phytoplanktons

Station No-3 **Year : 2005**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	2	4	5	5	6	12	3	2	6	5	6	4
Chlorella	0	0	0	0	2	3	4	1	0	0	0	0
Cosmarium	4	4	5	7	6	5	4	3	4	5	6	7
Eudorina	1	3	2	0	0	0	3	2	4	5	6	3
Hydrodicton	6	4	5	5	7	18	0	0	2	4	5	3
Microspora	2	4	5	6	8	15	3	2	3	6	8	8
Mougeotia	6	6	4	8	8	18	5	4	5	7	6	10
Pandorina	2	2	3	5	10	9	2	2	4	6	5	8
Pediastrum	8	7	6	7	11	20	4	1	3	5	8	6
Spirogyra	10	20	22	22	19	21	4	3	8	12	11	14
Ulothrix	20	17	13	12	15	12	1	0	3	5	9	8
Zygnema	3	2	5	8	4	7	2	0	0	0	4	5
Total	**64**	**73**	**75**	**85**	**96**	**140**	**35**	**20**	**42**	**60**	**74**	**76**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	2	4	4	5	7	8	8	0	0	0	3	2
Coconies	0	0	0	2	3	0	0	0	1	2	3	2
Fragillaria	0	1	2	2	3	11	2	3	1	3	4	3
Gomphonema	1	0	0	4	5	8	2	0	0	1	2	1
Nitchia Palaea	2	3	4	6	8	10	0	0	0	1	4	3
Synedraacus	3	2	3	4	5	9	3	2	2	4	5	6
Tabelloeria	1	1	3	2	8	12	0	0	4	4	2	3
Pinnularia	0	0	2	0	3	4	2	0	3	2	3	2
Total	**7**	**7**	**14**	**20**	**35**	**54**	**9**	**5**	**11**	**17**	**23**	**20**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	3	5	2	5	6	9	9	1	0	2	3	3
Anabaena	3	3	4	5	6	10	2	2	3	4	5	4
Cylinderospernum	0	0	3	2	5	12	2	1	1	2	3	2
Rivularia	4	2	4	5	8	9	2	0	1	0	4	7
Microcoleus	18	20	20	18	16	29	12	10	18	16	21	22
Vaucharia	0	0	2	2	4	5	0	0	3	4	2	1
Phormidium	5	5	8	7	8	18	15	6	4	6	8	7
Total	**33**	**35**	**43**	**44**	**53**	**92**	**42**	**20**	**30**	**34**	**46**	**46**
Grand Total	**104**	**115**	**132**	**149**	**184**	**286**	**86**	**45**	**83**	**111**	**143**	**142**

Table-26

Monthly Variation in Abundance of Phytoplanktons

Station No-4 **Year : 2005**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	2	5	5	6	7	9	2	1	3	4	5	4
Chlorella	3	6	8	7	9	11	2	1	3	4	6	4
Cosmarium	6	7	5	6	8	13	4	2	6	8	9	6
Eudorina	3	2	2	3	0	0	0	1	3	5	6	4
Hydrodicton	5	6	6	7	8	12	2	4	5	7	6	4
Microspora	4	5	6	8	12	15	1	2	4	5	6	4
Mougeotia	0	0	0	2	3	4	1	2	2	3	2	1
Pandorina	4	6	7	12	12	14	3	1	8	10	11	5
Pediastrum	7	7	6	8	10	20	0	2	4	6	5	4
Spirogyra	17	18	23	25	20	21	5	4	6	12	15	11
Ulothrix	16	10	13	15	12	12	0	0	3	5	8	9
Zygnema	5	6	4	6	7	16	3	2	3	2	3	5
Total	**72**	**78**	**85**	**105**	**108**	**147**	**23**	**22**	**50**	**71**	**82**	**61**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	4	3	6	6	5	10	0	0	2	2	1	2
Coconies	2	3	4	2	3	6	2	1	2	2	4	3
Fragillaria	3	2	5	4	6	9	1	0	0	1	2	2
Gomphonema	1	0	0	3	3	5	0	0	0	2	4	0
Nitchia Palaea	2	2	3	4	5	7	2	1	3	2	2	3
Synedraacus	3	4	4	3	5	8	2	3	4	3	2	4
Tabelloeria	3	2	3	4	7	10	0	0	0	5	6	4
Pinnularia	0	0	0	2	3	4	0	0	0	0	2	3
Total	**14**	**13**	**19**	**22**	**32**	**49**	**7**	**5**	**9**	**15**	**22**	**19**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	3	2	3	4	5	7	0	0	3	4	5	3
Anabaena	6	5	6	8	10	12	1	1	2	4	6	7
Cylinderospernum	0	0	0	1	2	4	0	0	0	2	3	2
Rivularia	4	2	3	4	4	8	3	2	4	3	6	4
Microcoleus	3	5	4	3	2	4	1	2	3	4	5	3
Vaucharia	2	1	2	4	5	10	2	3	5	6	7	5
Phormidium	5	4	3	5	8	15	6	5	7	9	10	6
Total	**23**	**19**	**21**	**29**	**36**	**60**	**13**	**13**	**24**	**32**	**42**	**30**
Grand Total	**109**	**110**	**125**	**156**	**176**	**256**	**43**	**40**	**83**	**118**	**146**	**110**

Table-27

Monthly Variation in Abundance of Phytoplanktons

Station No-1 **Year : 2006**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	4	6	7	10	12	15	5	2	3	7	8	4
Chlorella	5	6	7	11	14	14	3	2	5	6	7	3
Cosmarium	1	2	0	0	0	0	1	2	4	6	3	2
Eudorina	3	4	5	4	0	0	0	2	5	4	2	3
Hydrodicton	3	4	5	4	0	0	0	2	5	4	2	3
Microspora	0	0	3	5	5	8	2	1	3	2	4	3
Mougeotia	10	8	8	9	12	13	5	4	5	7	5	4
Pandorina	2	6	10	13	14	6	4	7	8	8	10	3
Pediastrum	11	8	4	9	12	31	0	3	3	7	9	4
Spirogyra	18	20	16	19	20	24	6	2	6	8	10	12
Ulothrix	19	14	13	15	13	10	0	0	0	4	6	9
Zygnema	4	5	3	3	0	0	0	0	4	4	2	3
Total	**80**	**83**	**81**	**102**	**102**	**121**	**26**	**27**	**51**	**67**	**68**	**53**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	4	3	3	4	6	10	2	2	4	5	6	3
Coconies	0	0	3	3	6	9	2	0	1	3	2	2
Fragillaria	8	7	9	10	14	18	4	5	6	4	7	8
Gomphonema	2	4	6	5	7	13	0	0	0	4	5	2
Nitchia Palaea	3	2	4	4	6	10	3	3	5	8	6	2
Synedraacus	4	5	5	6	8	14	5	4	6	5	8	6
Tabelloeria	5	8	8	14	16	18	8	6	7	6	9	10
Pinnularia	0	0	2	4	5	5	0	0	2	4	3	4
Total	**22**	**26**	**37**	**46**	**62**	**87**	**22**	**18**	**27**	**34**	**40**	**34**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	3	2	4	5	8	12	4	2	3	4	3	5
Anabaena	4	5	6	6	8	11	1	1	2	3	4	3
Cylinderospernum	2	2	2	3	4	8	2	2	4	3	2	3
Rivularia	3	4	4	5	8	10	5	0	0	0	4	3
Microcoleus	18	16	17	20	18	30	15	4	4	8	8	7
Vaucharia	3	5	5	4	7	14	2	0	0	3	2	4
Phormidium	0	0	3	3	5	8	3	2	4	5	3	2
Total	**33**	**34**	**41**	**46**	**58**	**93**	**32**	**11**	**17**	**26**	**26**	**27**
Grand Total	**135**	**143**	**159**	**194**	**222**	**301**	**80**	**56**	**95**	**127**	**134**	**114**

Table-28

Monthly Variation in Abundance of Phytoplanktons

Station No-2 **Year : 2006**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	3	4	6	10	10	15	4	3	4	5	6	5
Chlorella	3	5	6	11	13	10	2	2	1	4	6	5
Cosmarium	4	5	5	4	8	15	0	0	2	3	4	5
Eudorina	2	4	0	0	0	0	0	2	4	5	6	3
Hydrodicton	11	7	6	8	10	11	2	2	3	4	5	4
Microspora	3	2	2	2	3	4	0	0	0	3	4	3
Mougeotia	8	8	9	10	9	14	4	3	3	5	8	4
Pandorina	4	4	6	12	13	16	4	5	7	9	10	6
Pediastrum	7	8	7	9	12	19	0	2	4	7	10	5
Spirogyra	20	21	18	20	20	25	2	2	4	8	11	9
Ulothrix	18	10	13	14	14	12	0	0	0	6	10	8
Zygnema	6	6	8	10	11	13	0	0	4	6	9	7
Total	**89**	**84**	**86**	**110**	**123**	**154**	**18**	**21**	**36**	**65**	**89**	**64**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	5	4	5	6	10	12	3	2	3	5	6	4
Coconies	0	0	0	4	6	8	0	0	2	3	4	2
Fragillaria	6	8	10	9	12	20	6	4	8	8	10	9
Gomphonema	2	4	4	3	10	18	6	0	0	4	6	5
Nitchia Palaea	10	5	5	6	18	4	2	3	2	2	3	4
Synedraacus	5	3	14	13	18	24	3	2	4	6	10	8
Tabelloeria	3	4	6	7	7	18	6	4	5	5	8	10
Pinnularia	4	4	3	5	5	10	2	1	1	2	2	5
Total	**30**	**28**	**42**	**47**	**76**	**102**	**25**	**14**	**22**	**30**	**43**	**43**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	4	3	4	6	8	10	4	1	3	2	4	3
Anabaena	4	4	6	8	10	12	1	2	2	6	8	6
Cylinderospernum	0	0	0	4	5	11	3	4	3	4	5	2
Rivularia	3	2	2	4	5	8	0	0	2	3	4	3
Microcoleus	24	26	18	16	32	35	10	7	8	15	20	18
Vaucharia	2	1	2	3	4	5	0	0	0	0	2	3
Phormidium	4	4	3	3	3	7	2	2	3	4	5	3
Total	**41**	**40**	**35**	**44**	**67**	**88**	**20**	**16**	**21**	**34**	**48**	**38**
Grand Total	**160**	**152**	**163**	**201**	**266**	**344**	**63**	**51**	**79**	**129**	**180**	**145**

Table-29

Monthly Variation in Abundance of Phytoplanktons

Station No-3

Year : 2006

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	2	3	4	4	5	8	2	1	1	2	3	2
Chlorella	4	4	3	5	8	12	3	2	3	5	6	5
Cosmarium	5	4	8	7	7	9	4	1	0	3	2	4
Eudorina	1	4	0	0	0	0	3	2	4	5	7	3
Hydrodicton	5	5	6	8	8	14	0	0	3	6	8	10
Microspora	3	4	5	5	8	15	4	3	4	3	5	4
Mougeotia	7	7	8	9	10	11	2	0	0	4	6	5
Pandorina	4	5	9	12	12	11	1	0	6	8	7	4
Pediastrum	10	9	6	7	11	27	0	0	2	7	8	3
Spirogyra	16	22	23	24	26	26	2	0	8	10	12	10
Ulothrix	18	14	14	15	13	12	0	0	3	5	8	10
Zygnema	2	3	3	4	5	8	2	2	3	5	6	4
Total	**77**	**84**	**89**	**100**	**113**	**153**	**23**	**11**	**37**	**63**	**78**	**64**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	4	4	5	8	8	10	3	0	0	2	4	6
Coconies	2	3	2	2	0	0	0	1	1	3	2	2
Fragillaria	4	3	3	6	10	10	4	3	5	8	7	3
Gomphonema	1	1	3	2	4	5	1	1	2	2	3	2
Nitchia Palaea	3	2	4	5	8	12	4	2	2	3	4	2
Synedraacus	2	3	5	5	6	10	0	0	0	2	3	2
Tabelloeria	2	2	4	5	8	11	6	4	6	7	8	6
Pinnularia	0	0	3	4	5	2	0	0	1	2	4	3
Total	**14**	**14**	**24**	**29**	**41**	**50**	**15**	**11**	**17**	**27**	**31**	**20**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	2	1	2	3	4	6	0	0	0	2	3	4
Anabaena	3	5	7	10	10	15	2	4	5	6	6	4
Cylinderospernum	0	0	4	5	6	10	3	0	6	4	6	3
Rivularia	2	8	9	9	10	4	0	0	0	0	0	2
Microcoleus	20	19	17	18	20	30	4	5	7	8	15	13
Vaucharia	0	0	4	5	8	12	3	2	4	5	6	4
Phormidium	5	6	6	8	15	18	6	5	6	8	10	7
Total	**32**	**39**	**49**	**58**	**73**	**95**	**18**	**16**	**28**	**33**	**46**	**37**
Grand Total	**123**	**137**	**162**	**187**	**227**	**298**	**56**	**38**	**82**	**123**	**155**	**121**

Table-30

Monthly Variation in Abundance of Phytoplanktons

Station No-4 **Year : 2006**

Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ankistrodesmus	3	4	6	6	8	10	2	1	3	4	5	4
Chlorella	4	6	8	7	10	15	4	4	5	6	8	5
Cosmarium	7	8	8	10	12	16	6	4	4	6	9	7
Eudorina	1	2	0	0	0	1	2	4	5	6	7	5
Hydrodicton	4	5	6	8	14	15	3	2	4	4	6	3
Microspora	3	4	6	6	8	10	2	2	3	5	7	4
Mougeotia	0	0	3	3	4	5	0	0	0	2	3	2
Pandorina	3	7	7	14	14	13	0	0	6	8	10	6
Pediastrum	8	9	8	10	12	20	4	3	4	5	6	7
Spirogyra	16	18	20	19	22	25	2	0	8	10	12	10
Ulothrix	15	18	20	25	23	21	0	0	0	10	12	8
Zygnema	4	4	6	7	10	18	3	2	4	7	9	8
Total	**68**	**85**	**98**	**115**	**137**	**169**	**28**	**22**	**46**	**73**	**94**	**69**
Becillariophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Amphipleura	2	2	4	5	8	12	0	0	0	2	4	2
Coconies	3	2	4	6	6	8	1	0	2	1	3	1
Fragillaria	2	2	4	6	10	11	0	0	1	4	5	3
Gomphonema	1	0	0	2	4	5	1	0	0	2	3	2
Nitchia Palaea	3	2	2	3	4	8	3	2	2	4	4	3
Synedraacus	0	0	4	6	8	10	4	2	2	3	5	4
Tabelloeria	4	3	4	8	8	11	0	0	3	5	8	4
Pinnularia	1	0	2	4	6	4	0	0	0	0	3	2
Total	**14**	**9**	**20**	**35**	**46**	**57**	**9**	**4**	**10**	**19**	**31**	**19**
Cynophyceae	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Agmenellum	2	3	3	4	4	5	0	0	2	3	4	3
Anabaena	6	7	7	9	8	10	2	1	0	4	5	4
Cylinderospernum	0	0	0	4	6	6	0	0	1	3	2	2
Rivularia	5	7	8	8	12	14	2	0	0	0	0	0
Microcoleus	4	4	5	6	8	12	4	3	6	8	10	10
Vaucharia	3	2	4	5	5	13	2	2	3	6	8	7
Phormidium	8	5	6	6	10	18	7	4	5	7	12	9
Total	**28**	**28**	**33**	**42**	**53**	**78**	**17**	**10**	**17**	**31**	**41**	**35**
Grand Total	**110**	**122**	**151**	**192**	**236**	**304**	**54**	**36**	**73**	**123**	**166**	**123**

Table-31

Monthly Variation in Abundance of Zooplankton

Station No.- 1 | **Year : 2005**

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	4	7	7	12	15	17	1	1	2	4	6	3
Arcella	1	2	3	5	5	7	1	1	2	2	3	2
Euglena	1	6	10	11	13	15	0	0	2	3	6	0
Euglypha	0	1	2	2	4	6	0	0	1	1	0	0
Metopus	0	0	0	2	4	6	0	0	0	0	0	0
Paramecium	3	3	5	5	8	10	0	0	3	4	5	2
Verticella	1	2	3	3	4	6	0	0	1	3	4	2
Total	**10**	**21**	**30**	**40**	**53**	**67**	**2**	**2**	**11**	**17**	**24**	**9**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	2	5	10	12	14	17	1	0	8	12	14	2
Brachionus	10	5	9	12	15	19	3	1	4	6	11	14
Fielina	0	3	2	1	5	3	2	2	3	8	1	0
Keratella	1	2	2	3	5	7	0	0	0	4	5	2
Testudinella	0	0	2	4	6	8	1	1	2	3	4	2
Total	**13**	**15**	**25**	**32**	**45**	**54**	**7**	**4**	**17**	**33**	**35**	**20**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	1	2	2	4	6	7	1	1	2	4	4	2
Ceriodaphnia	2	4	8	5	5	5	0	0	1	2	2	1
Daphnia	12	18	20	22	28	8	0	0	0	9	9	12
Moina	5	8	10	20	19	15	4	3	1	3	5	2
Oxyurella	2	7	9	11	14	7	5	2	3	4	6	5
Total	**22**	**39**	**49**	**62**	**72**	**42**	**10**	**6**	**7**	**22**	**26**	**22**
b- Copepoda												
Allodiaptomos	5	6	4	10	9	3	2	2	4	6	8	4
Cyclops	3	2	6	12	30	20	21	4	5	14	34	36
Diaptomus	4	6	8	7	9	18	16	0	0	4	10	3
Ergasilus	4	2	2	4	3	2	0	0	2	4	6	6
Macrocyclops	7	6	8	10	12	15	4	3	6	8	10	5
Mesocyclops	0	0	0	12	6	4	0	0	4	16	14	0
Total	**23**	**22**	**28**	**55**	**69**	**62**	**43**	**9**	**21**	**52**	**82**	**54**
Grand Total	**68**	**97**	**132**	**189**	**239**	**225**	**62**	**21**	**56**	**124**	**167**	**105**

Table 32

Monthly Variation in Abundance of Zooplankton

Station No.- 2 Year : 2005

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	3	7	7	11	16	18	14	12	6	3	5	3
Arcella	2	2	4	6	7	9	2	1	2	3	4	2
Euglena	1	2	5	5	6	8	0	0	1	3	2	0
Euglypha	2	4	4	6	6	7	0	0	0	1	3	1
Metopus	0	0	0	4	7	7	0	0	0	0	0	0
Paramecium	4	5	5	8	9	12	2	2	3	5	5	3
Verticella	2	2	4	6	7	15	0	0	0	0	3	2
Total	**14**	**22**	**29**	**46**	**58**	**76**	**18**	**15**	**12**	**15**	**22**	**11**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	4	10	15	20	21	24	3	2	9	12	18	4
Brachionus	12	4	10	14	18	20	4	1	4	9	12	14
Fielina	0	0	3	2	6	4	2	2	3	12	2	0
Keratella	0	0	0	0	0	6	4	3	2	16	4	0
Testudinella	0	0	4	6	6	8	0	0	2	2	3	2
Total	**16**	**14**	**32**	**42**	**51**	**62**	**13**	**8**	**20**	**51**	**39**	**20**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	2	3	5	5	5	3	2	1	4	3	5	2
Ceriodaphnia	3	3	10	10	9	14	0	0	3	3	4	3
Daphnia	7	18	20	25	42	7	0	0	0	10	9	12
Moina	6	9	12	24	20	16	3	3	1	3	6	2
Oxyurella	3	6	9	9	8	12	3	2	4	6	5	4
Total	**21**	**39**	**56**	**73**	**84**	**52**	**8**	**6**	**12**	**25**	**29**	**23**
b- Copepoda												
Allodiaptomos	6	7	8	9	13	6	4	4	6	8	6	3
Cyclops	5	4	6	24	30	18	20	4	3	14	32	33
Diaptomus	5	7	9	8	12	16	1	1	4	3	6	4
Ergasilus	5	3	3	5	3	2	0	0	2	5	7	6
Macrocyclops	6	6	9	13	12	15	4	4	6	8	12	7
Mesocyclops	0	0	0	10	5	4	0	0	3	15	13	0
Total	**27**	**27**	**35**	**69**	**75**	**61**	**29**	**13**	**24**	**53**	**76**	**53**
Grand Total	**78**	**102**	**152**	**230**	**268**	**251**	**68**	**42**	**68**	**144**	**166**	**107**

Table-33

Monthly Variation in Abundance of Zooplankton

Station No.-3 **Year : 2005**

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	2	6	5	10	15	17	18	16	5	4	6	5
Arcella	2	3	4	8	11	14	1	2	2	5	4	3
Euglena	2	6	6	12	15	18	20	16	5	4	6	5
Euglypha	1	2	4	4	6	8	0	0	2	3	0	0
Metopus	0	0	0	5	8	6	0	0	0	0	0	0
Paramecium	3	3	5	5	8	14	2	1	3	2	3	2
Verticella	2	3	5	7	7	12	0	0	0	0	2	3
Total	**12**	**23**	**29**	**51**	**70**	**89**	**41**	**35**	**17**	**18**	**21**	**18**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	4	12	16	20	24	25	2	6	10	14	16	7
Brachionus	16	6	11	14	20	21	2	1	5	8	15	16
Fielina	5	6	12	14	16	18	20	0	0	6	8	4
Keratella	2	4	6	11	12	15	3	2	5	8	7	6
Testudinella	1	2	0	0	8	8	2	0	0	0	2	1
Total	**28**	**30**	**45**	**59**	**80**	**87**	**29**	**9**	**20**	**36**	**48**	**34**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	3	3	7	7	7	4	2	1	4	3	6	2
Ceriodaphnia	3	3	10	9	12	14	0	0	2	2	6	4
Daphnia	6	20	24	25	48	7	0	0	0	10	9	12
Moina	2	2	3	4	6	6	2	1	2	4	6	3
Oxyurella	2	4	10	9	12	13	3	2	5	4	8	6
Total	**16**	**32**	**54**	**54**	**85**	**44**	**7**	**4**	**13**	**23**	**35**	**27**
b- Copepoda												
Allodiaptomos	5	8	7	9	10	8	3	2	16	14	5	4
Cyclops	5	4	8	25	30	19	22	4	3	15	30	32
Diaptomus	4	6	8	7	10	14	0	0	5	4	6	3
Ergasilus	4	3	4	3	2	0	0	0	3	6	8	4
Macrocyclops	5	5	10	10	10	13	3	3	6	6	7	5
Mesocyclops	0	0	0	6	9	4	0	0	4	16	15	3
Total	**23**	**26**	**37**	**60**	**71**	**58**	**28**	**9**	**37**	**61**	**71**	**51**
Grand Total	**79**	**111**	**165**	**224**	**306**	**278**	**105**	**57**	**87**	**138**	**175**	**130**

Table-34

Monthly Variation in Abundance of Zooplankton

Station No.-4 **Year : 2005**

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	2	3	5	7	13	16	18	10	13	5	8	6
Arcella	2	3	6	6	9	12	1	1	3	5	6	4
Euglena	3	5	8	12	14	19	0	0	2	5	6	3
Euglypha	4	4	6	5	6	10	0	0	4	5	0	1
Metopus	0	0	0	4	6	8	0	0	0	0	0	0
Paramecium	3	5	7	8	12	14	2	1	3	6	8	3
Verticella	2	3	6	8	10	13	0	0	0	0	0	0
Total	**16**	**23**	**38**	**50**	**70**	**92**	**21**	**12**	**25**	**26**	**28**	**17**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	4	8	12	17	22	26	26	2	4	8	13	5
Brachionus	15	5	9	12	20	19	4	1	4	6	11	12
Fielina	0	3	2	1	6	6	2	2	3	8	1	0
Keratella	0	0	0	0	0	7	3	4	10	12	2	0
Testudinella	1	2	0	0	8	8	0	3	0	0	3	2
Total	**20**	**18**	**23**	**30**	**56**	**66**	**35**	**12**	**21**	**34**	**30**	**19**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	2	4	7	7	8	3	2	1	4	4	6	3
Ceriodaphnia	2	2	7	9	12	8	0	0	2	4	4	2
Daphnia	7	10	15	17	25	9	0	0	0	9	9	4
Moina	5	9	11	20	19	15	4	3	1	3	6	3
Oxyurella	3	4	7	8	10	14	3	2	6	7	8	4
Total	**19**	**29**	**47**	**61**	**74**	**49**	**9**	**6**	**13**	**27**	**33**	**16**
b- Copepoda												
Allodiaptomos	4	9	10	11	12	12	3	2	5	8	4	3
Cyclops	5	7	9	21	32	18	21	4	6	12	30	34
Diaptomus	4	6	7	7	11	15	0	0	5	4	7	4
Ergasilus	5	3	6	3	2	0	0	0	3	7	6	3
Macrocyclops	4	5	9	10	12	3	2	4	5	6	7	4
Mesocyclops	0	0	0	5	10	6	0	0	5	15	6	0
Total	**22**	**30**	**41**	**57**	**79**	**54**	**26**	**10**	**29**	**52**	**60**	**48**
Grand Total	**77**	**100**	**149**	**198**	**279**	**261**	**91**	**40**	**88**	**139**	**151**	**100**

Table-35

Monthly Variation in Abundance of Zooplankton

Station No.-1

Year : 2006

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	6	8	9	15	18	10	1	1	2	4	6	2
Arcella	1	3	4	5	8	9	0	0	2	3	3	2
Euglena	2	4	9	12	14	18	0	0	0	3	6	4
Euglypha	0	0	2	4	2	6	0	0	0	1	2	0
Metopus	0	0	0	3	5	7	0	0	0	0	0	0
Paramecium	3	4	5	6	6	12	0	0	3	5	8	3
Verticella	2	4	3	5	7	8	0	0	0	2	5	3
Total	**14**	**23**	**32**	**50**	**60**	**70**	**1**	**1**	**7**	**18**	**30**	**14**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	3	4	8	14	15	19	2	0	0	9	15	3
Brachionus	12	4	8	10	16	22	4	2	2	6	18	10
Fielina	0	0	3	4	1	5	3	2	2	3	9	0
Keratella	2	2	3	2	6	9	0	0	0	5	6	3
Testudinella	0	0	4	6	6	10	2	1	3	3	5	4
Total	**17**	**10**	**26**	**36**	**44**	**65**	**11**	**5**	**7**	**26**	**53**	**20**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	2	4	3	4	8	10	2	1	3	6	8	3
Ceriodaphnia	3	5	9	6	7	6	0	0	2	4	3	2
Daphnia	13	15	20	22	26	9	0	0	0	8	10	12
Moina	4	6	8	15	12	18	6	2	3	8	10	4
Oxyurella	3	8	10	12	15	8	4	0	4	6	8	5
Total	**25**	**38**	**50**	**59**	**68**	**51**	**12**	**3**	**12**	**32**	**39**	**26**
b- Copepoda												
Allodiaptomos	6	4	8	12	13	4	5	2	2	6	10	5
Cyclops	4	2	6	14	32	24	20	5	6	12	30	32
Diaptomus	5	8	7	17	10	25	18	4	3	2	8	6
Ergasilus	5	4	4	3	2	4	2	4	6	4	8	3
Macrocyclops	8	6	9	10	12	18	4	3	5	8	12	7
Mesocyclops	0	0	0	15	8	5	0	0	0	16	14	0
Total	**28**	**24**	**34**	**71**	**77**	**80**	**49**	**18**	**22**	**48**	**82**	**53**
Grand Total	**84**	**95**	**142**	**216**	**249**	**266**	**73**	**27**	**48**	**124**	**204**	**113**

Table-36

Monthly Variation in Abundance of Zooplankton

Station No.-2

Year : 2006

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	3	7	8	14	15	18	20	15	6	3	8	2
Arcella	2	2	5	6	7	10	3	1	2	2	4	3
Euglena	4	5	10	16	18	22	0	0	4	8	6	0
Euglypha	2	3	4	4	17	20	0	0	7	5	4	2
Metopus	0	0	0	3	7	8	0	0	0	0	0	0
Paramecium	3	5	5	6	8	12	2	2	3	5	5	4
Verticella	2	2	4	6	7	15	0	0	0	0	2	2
Total	**16**	**24**	**36**	**55**	**79**	**105**	**25**	**18**	**22**	**23**	**29**	**13**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	6	11	15	21	24	25	3	2	8	10	14	4
Brachionus	15	6	12	16	20	24	3	1	3	7	12	15
Fielina	2	3	2	2	6	3	2	2	3	10	2	0
Keratella	0	0	0	0	0	6	5	3	2	15	2	3
Testudinella	0	0	3	4	6	8	2	1	2	4	5	0
Total	**23**	**20**	**32**	**43**	**56**	**66**	**15**	**9**	**18**	**46**	**35**	**22**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	6	5	5	7	8	1	1	3	5	5	6	3
Ceriodaphnia	2	2	8	7	8	14	0	0	2	3	4	3
Daphnia	5	24	25	35	50	8	0	0	0	5	15	12
Moina	5	10	12	24	22	15	3	2	2	3	5	2
Oxyurella	3	6	10	9	12	16	3	2	4	6	5	3
Total	**21**	**47**	**60**	**82**	**100**	**54**	**7**	**7**	**13**	**22**	**35**	**23**
b- Copepoda												
Allodiaptomos	6	8	8	10	12	6	4	3	6	7	6	4
Cyclops	5	5	7	28	30	20	22	5	4	18	32	34
Diaptomus	3	4	5	9	10	15	4	2	2	6	8	5
Ergasilus	5	3	3	4	3	2	0	0	0	4	5	4
Macrocyclops	6	6	9	12	12	14	4	4	6	8	5	6
Mesocyclops	0	0	0	10	5	4	0	0	3	15	13	0
Total	**25**	**26**	**32**	**73**	**72**	**61**	**34**	**14**	**21**	**58**	**69**	**53**
Grand Total	**85**	**117**	**160**	**253**	**307**	**286**	**81**	**48**	**74**	**149**	**168**	**111**

Table-37

Monthly Variation in Abundance of Zooplankton

Station No.-3 **Year : 2006**

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	5	6	7	10	14	20	17	16	5	4	6	5
Arcella	3	3	5	6	8	10	2	1	3	2	3	2
Euglena	2	6	8	12	16	19	0	0	2	4	8	6
Euglypha	2	3	4	4	6	8	0	0	2	3	0	0
Metopus	0	0	0	4	5	7	0	0	0	0	0	0
Paramecium	2	3	4	8	13	12	1	2	2	4	4	3
Verticella	2	3	5	6	8	14	0	0	0	0	1	3
Total	**16**	**24**	**33**	**50**	**70**	**90**	**20**	**19**	**14**	**17**	**22**	**19**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	4	8	12	21	24	25	2	7	11	12	14	6
Brachionus	15	6	10	15	20	23	3	2	4	7	15	14
Fielina	5	7	13	12	11	16	2	4	5	8	7	5
Keratella	3	5	6	11	14	16	2	3	5	8	7	5
Testudinella	0	0	3	2	5	7	2	0	0	4	6	0
Total	**27**	**26**	**44**	**61**	**74**	**87**	**11**	**16**	**25**	**39**	**49**	**30**
Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	4	5	4	6	6	3	2	1	4	3	6	2
Ceriodaphnia	4	4	8	9	10	14	0	0	2	2	4	3
Daphnia	8	20	24	32	48	5	0	0	0	11	9	13
Moina	3	1	3	4	6	6	3	1	2	4	5	4
Oxyurella	2	4	9	12	14	10	3	2	5	6	8	5
Total	**21**	**34**	**48**	**63**	**84**	**38**	**8**	**4**	**13**	**26**	**32**	**27**
b- Copepoda												
Allodiaptomos	5	8	7	9	10	9	3	2	7	8	5	4
Cyclops	6	7	9	24	32	20	22	5	4	16	28	33
Diaptomus	4	7	6	18	12	24	19	4	3	4	15	5
Ergasilus	3	4	3	2	4	2	0	0	3	6	8	4
Macrocyclops	5	5	8	10	9	10	3	3	6	7	8	5
Mesocyclops	0	0	0	8	5	4	0	0	4	16	15	0
Total	**23**	**31**	**33**	**71**	**72**	**69**	**47**	**14**	**27**	**57**	**79**	**51**
Grand Total	**87**	**115**	**158**	**245**	**300**	**284**	**86**	**53**	**79**	**139**	**182**	**127**

Station No.-4

Table-38

Monthly Variation in Abundance of Zooplankton

Year : 2006

Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanphocystis	3	3	5	8	10	22	4	2	3	5	8	4
Arcella	2	4	6	10	12	11	2	1	2	5	7	4
Euglena	3	6	11	12	18	20	3	2	3	4	6	3
Euglypha	2	3	4	6	5	9	2	4	3	2	0	0
Metopus	0	0	0	4	6	6	0	0	0	0	0	0
Paramecium	2	4	7	8	10	13	2	0	2	6	5	3
Verticella	2	3	5	6	8	11	0	0	0	0	0	0
Total	**14**	**23**	**38**	**54**	**69**	**92**	**13**	**9**	**13**	**22**	**26**	**14**
Rotifera	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Asplanchna	6	8	10	21	28	30	4	3	10	18	15	7
Brachionus	16	6	9	17	18	23	4	2	3	7	13	14
Fielina	0	2	2	3	6	3	2	2	4	9	1	0
Keratella	0	0	0	0	0	5	4	5	3	18	4	0
Testudinella	4	5	6	12	16	14	4	3	6	8	2	1
Total	**26**	**21**	**27**	**53**	**68**	**75**	**18**	**15**	**26**	**60**	**35**	**22**
Crustacea		**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a-Cladocera												
Alonella	2	3	4	8	6	3	2	1	3	4	7	3
Ceriodaphnia	2	2	8	10	12	11	0	0	2	3	3	2
Daphnia	6	11	13	25	20	14	6	3	1	2	6	4
Moina	5	12	14	18	16	14	4	2	3	10	9	11
Oxyurella	3	5	6	9	10	15	3	1	6	6	7	3
Total	**18**	**33**	**45**	**70**	**64**	**57**	**15**	**7**	**15**	**25**	**32**	**23**
b- Copepoda												
Allodiaptomos	3	9	10	11	13	12	3	2	6	7	4	3
Cyclops	5	6	8	24	30	16	22	4	6	14	30	36
Diaptomus	3	6	8	8	12	15	0	0	4	5	8	3
Ergasilus	5	4	5	4	3	2	0	0	3	7	9	5
Macrocyclops	4	6	10	11	12	16	2	1	5	6	4	2
Mesocyclops	0	0	0	8	13	6	0	2	4	10	18	0
Total	**20**	**31**	**41**	**66**	**83**	**67**	**27**	**9**	**28**	**49**	**73**	**49**
Grand Total	**78**	**108**	**151**	**243**	**284**	**291**	**73**	**40**	**82**	**156**	**166**	**108**

DISCUSSION

DISCUSSION

The water is one of the essential requirements of life. A very small fraction of the total water present in the world is available for human consumption. India has unique advantage of having several large rivers which play an important role in irrigation, industry, hydropower generation aquatic biota, fish production, and inland water transport besides domestic water supply. Water is a good solvent, number of water soluble toxicants are rapidly transferred to natural water sources by way of leaching from the soil. Safety of drinking water is decided by the quality and quantity of dissolved chemicals, A few chemicals present in drinking water sources as contaminants, may threaten the well being of man, animal and vegetations. The water resources and management for better utility is given by detailed in formation.

Rao (1975) in his book entitled " India's water wealth." We need to protect the quality and quantity of this water wealth.

It is very essential at present to study the different aspects by which these rivers have been badly effected and loosing their natural nature. There are thousands of people who are still accustomed to use the raw water that is available in the rivers and canals for domestic use including drinking purposes. However, the target to meet the needs of the entire population in our country is not upto the mark.

Having in view of these problems, the river Mandakini is studied by taking their Physical, chemical & Biological Characteristics considering required factors for every aspect. Besides, the meterological conditions are also recorded because they have direct impact on aquatic life. They are atmospheric temperature, rainfall, relative humidity and photo period. Besides, mean standard deviations and co-efficient correlation were statically calculated.

Metrological Conditions

Atmospheric Temperature

The maximum atmospheric Temperature 41.4 ^{0}C was found in the month of May and Minimum 10.2^{0}C in winter season in the month of December, 2005 and in 2006, it was highest 41.3^{0}C in the month of May and Lowest 11.2^{0}C in the month of December. So the atmospheric temperature has directly impact on water temperature which affects the primary production of entire aquatic biota. Atmospheric temperature showed positive relationship with photo period and humidity Rainfall impacts negatively on it.

Rain Fall

The rainfall depends on Monsoon which increases turbidity of river water due to silting and presence of decaying organic matter brought along with the surface run off. It was highest 757.8 mm in the month of July and Lowest was 4.9mm. in the month of October in 2005 and in 2006, the highest 452.1mm was in the month of July and Lowest 0.6mm. was in the month of November. The high rainfall during monsoon along with high turbidity decreases the concentration of of D.O. as well as poto synthetic activities in River biota.

Relative Humidity

It was maximum 86.29% in month of July and minimum 16.37% in April in 2005 and in 2006, it was maximum 86-74% in the month of August and minimum 18.68% in the month of April. It increased in monsoon season and decrease in winter season. It is negatively related with atmospheric temperature and positively with rainfall. It increases in cloudy weather and high rains decreases the photosynthesis activities in river water as well as affects the primary productivity of biota of the river.

Photoperiod

It was Maximum 13.54 Hrs. in month of Jun and Minimum 10.47 Hrs. in December, in 2005 and in the year 2006, it was maximum 13.64 Hrs. in month of Jun. and Minimum 10.54 Hrs. in December. It was Found maximum due to high intensity of solar radiation in summer season and minimum in winter seson. Which increase the rate of Photosynthesis so it is directly co-related.

Physico-chemical and biological characteristics

For the assessment the quality of river water Physicochemical and biological factors which were considered are:-

Physical Factors

Water Temperature, Turbidity water current and colour

Chemical Factors

Hydrogen-ion-concentration (p^H), Total alkalinity, Total hardness, Ca hardness, Mg hardness total Chloride, D.O. CO_2, BOD., COD., Ammonical Nitrogen, Nitrite Nitrogen, Nitrate Nitrogen, Phosphate, Sulphate, Sodium, Potassium and fluoride.

Biological Factors

Total Coliform (MPN), Phyto and zooplanktons Aquatic weeds and fish fuana.

Physical Factors

Water Temperature

It is quite important factor among all. which is an accelerater or moderator in all life processes. It plays a vital role in the decomposition of organic materials and also had a major influence on the metabolic activities of organisms. Besides, It influences the solubility of gases and salts in water. In general oxygen contents of

water decreases with increase in temperature. The water temperature changes according to atmospheric temperature. Obviously both have postive co-relationship.

In the present study water temperature varied between 18.04°C to 33.05°C in the year 2005 and between 17°C to 33.65°C in the year 2006 at different sampling stations. Its mean value. was 26.93°C to 25.97°C in the year 2005 and between 25.78°C to 26.31°C in the year 2006 of different sampling stations. Minimum water temperature was recorded in the month of January during winter season while the highest temperature was noticed in the month of June during summer season. Amongst all sampling stations (I to IV) the water temperature was found to be comparatively higher at station III and IV due to human activities, low water level which had high insulation from solar radiation and sewage discharges. Fecal matters and much growth of coliform bacteria.

A comparison of these fluctuations indicates that the water temperature increases with increasing the pollution status in it. There were some variation in temperature in water bodies with respect to the month which is dependent upon the seasons. Seasonal fluctuations in the temperature of water bodies were reported by Singh et. al. (1982). Bilgrami et. al. (1986)., Ramanibai and Ravichandran, (1987). These reportes are in confermity with the present investigation.

The temperature in river water showed positive correlation with P^H, total alkalinity, total hardness, Calsium hardness, Mangnesium hardness, Cl, COD., BOD, CO_2, NH_4-N, PO_4, SO_4 Na, K and MPN but negative correlation was found with D.O Rainfall, relative humidity. As stated tables of coefficient correlation. Hrishnamurthy et. al. (1994) reported the water temperature of Kali nadi to be 25.7°C to 30°C at different sites. Higher temperature during summer was due to greater heating of water and insolent heat form sun-onset of monsoon results in fall in temperature of

water bodies because clouds act as barrier in the Process of heating. Microbial activities increase by higher temperature which decrease dissolved O_2 in water and cause asphyxiation on fishes and it may be fatal, this results occasional fish martality (Jhingaran 1991) Baruah et. al. (1995) determined the Physico-chemical characteristics of river Jhanji in Assam and found the temperature range between 23.2 and 35.4^{0}C.

Temperature affects the quality of water as regards its potability and recreational nature. Singh et. al. (1995) studied the impact of river Yamuma on Ganga river water quality at Varanasi and found that the temperature of the river water fluctuated between 21^{0}C in winter and 30.5^{0}C in summer season. The variations of the temperature reported by various workers marked it as the limiting factor for the aquatic biota. Increase in temperature at polluted stations may be attributed to a lot of chemical changes in domestic discharged, municipal water and sewage wastes which reach in the river.

Temperature measurments are useful in indicating the levels of chemical, biological and bio-chemical activities along with saturation values of solids and gases present in water. It is one of the limiting factors for aquatic biota along with fishes. As all metabolic physiological activities as well as life processes viz. Reproduction, feeding, movement and distribution of aquatic organisms are highly influenced by water temperature in rivers. Because seasonal qualitative and quantitative fluctuations occur in the planktonic populations due to variations in temperature. Ganapati and Rao (1954), and Chen (1965) observed that the seasonal variations in the density of copepods was influenced by temperatures. Regarding the role of temperature in regulating the seasonal aboundant of different groups of zooplankton, varying statement and have been put forward, Byars (1960) reported

that the temperature had the greatest influence on the productivity of Rotifers. The density of planktons increases by rise in temperature hence they show the positive co-relationship.

Adholia (1986) studied betwa river and found temperature Variation from 17.2°C to 21°C. The observations resemble to the finding of Chacko and Srinivasan (1955) who reported hydro biological features of river Godavari and found the water temperature ranged from 27°C to 36.4°C. Trivedi et. al. (1990) reported the temperature of river Krishna between 20.0°C and 35.5°C. Agrawal (1993) studied the Physico-chemical and biological characteristics of river Betwa from Nayapura to Vidisha and found that the Temperature varied between 16°C and 35°C.

The present work as regards water temperature and Aquatic Drganisms relationship also resembles with above work. Besides,the present work is in conformity with the works of Saha et. al. (1971), Khan and Siddiqui (1974).

Turbidity

It is the transparancy in natural water and majourly caused by heavy rains, floods, wind velocity, suspended inorganic substances such as silt and clay, phytoplanktons and other microscopic organisms. It is also caused by the substances having size more than 10^{-9}m. Stone quarrying works. Sand washing China, Clay works are inorganic wastes and they increase turbidity. Domestic wastes sewage, effluents and washings etc.cause turbidity. Turbidity adversely affects the productivity of biota due to interference in light penetration, which plays great role in photosynthetic activity. Jhingaran (1991) reported that the fish fertility in very highly turbid water is badly affected along with its flora and fauna. Turbid water creates problems in water treatment plants and it is unfit for domestic purposes and many other industrial uses and interferes with the self purification of streams and river by reducing the

photosynthetic activity of waterplants and by smoothing benthic organisms. In the present study, Turbidity varied between 14.0 to 79.0 N.T.U. in 2005 and in 2006 ranged between 15.10 to 90.0 N.T.U. The highest value of it recorded in the month of July and Lowest value recorded in the month of December in both the years. The higher value was in monsoon period due to silting, organic matter, flow of surface run off while in summer low water level, and high wind velocity are its causes. The mean value of turbidity during the study period ranged from 28.58 to 50.67 N.T.U. in first year 2005 and in 2006, was from 31.46 to 53.17 N.T.U.

Turbidity has been traditionally measured in J.T.U. (Jackson Turbidity Unit). Currently Nephlometric Turbidity Units (NTU) are used employing Nephlometer in turbidity estiamation. The health limit for turbidity is 5 N.T.U. as recommended by W.H.O. for drinking water whereas Indian standared permit it to 10N.T.U. in the obsence of any other alternative source.

This river passes through urban areas where domestic and sewage waste water,treated or untreated may be added. The domestic waste may add great quantities of organic and some inorganic materials reaching rivers serve as food for bacterial growth and other micro-organisms that feed upon the bacteria and produce additional turbidity.

In this field the various important river water were studied by different workers and recorded turbidity as given bellow:-

Wilson (1959) reported that it hampers the spawning and growth of fishes due to lack of oxygen availabiliy various suspended particles reduce dissolved oxygen in water due to ill effects of Photosynthetic activity. Jhingaran (1991) investigated that the suspended particles absorb considerable amount of nutrient elements like

Phosphates, Potassium and Nitrogen in the ionic forms making them unavailable for Plankton production, Upadhyay (1997) reported the turbidity in the range between 2N.T.U. to 162 N.T.U. in Kaliasote dam. The variations of the turbidity in water reported by above workers shows that it is a limiting factor.

Turbidity showed positive correlation with total alkalinity, Cl, B.O.D, C.O.D., CO_2, NH_4N, PO_4 Na, K, Fl, Temperature, pH, M.P.N., and Negative correlation with total hardness D.O., SO_4, Photosynthetic activity. Turbidity decreases photosynthetic activities due to restriction of light penetration which adversely affects the productivity of aquatic biota as well as reduction of dissolved oxygen.

The observation of turbidity concides with the observation of Roy (1955) and Jhingaran (1991). Murugesan et. al. (1994) assessed the water quality of river Tamprapani and reported the turbidity between 5.0 N.T.U. to 20.0 N.T.U. Krishnamurthy and Bharati (1994) studied the turbidity between 2.7 to 35.5 N.T.U. in Kalindi. Kataria et. al. (1996) studied the turbidity between 8.0 to 40 N.T.U. of Tawa reservoir.

Water Current

Water current is one of the important factors which has a direct relationship with the turbidity and plankton population. The slow water flow in summer echonces the organic materials. This expresses that the reduction in the water swiftness promotes the better nich for the plankton community.

In the present study the current of river ranged 7.0Cum./ Sec. to 1005.0 Cum/Sec. in 2005 and in 2006, 7.0 Cum/Sec. to 1016.0 Cum/ Sec. The highest value of water current was observed in the month of August, due to floods in rainy season and the lowest value of water current was recorded in the month of Jun in

both the years. The mean value of it ranged from 208.78Cum./Sec to 218.39 Cum./ Sec. in 2005. While in 2005 varied between 209.11Cum./Sec. to 218.81 Cum./ Sec. This was found increased from station- I, II and III in the month of August the variation are due to flood in span of the river.

During the summer the river becomes a slow spill channel like a trickling stream, due to almost nil rains. Water current showed positive correlation with turbidity. Obviously water current plays a great role and fertility as well as production of fish. The maximum water current of a flowing stream in its vertical section is generally found some where with in the one third of the depth of the water from the surface. It has a bearing on the rheotrophic movement of planktonic organisms fish etc.

The water current is reduced at and near the surface because of surface tension and is diminished at the sides and the bottom of the river bed due to frictional effects. Berner (1951) and Roy (1955) reported that it is a detrimental factor.

The main feature of influx significance of the river is the silt laden water flow which was recorded maximum during the mansoon period because of the high flood. George et. al. (1966) studied the limnological survey of river Kali with reference to fish mortality and found water current varied from 14 to 2,545 cts. It affects fish productivity as well as fishing in river. Slow and gentle current velocity was conclusive to fish catches. While faster current of the river water proved unfavourable spawn collection.

Besides It showed positive correlation with turbidity, CO_2, Na, K, Fl, M.P.N. and a negative correlation with pH, T.A., Total hardness, Cl, D.O., B.O.D., C.O.D. at some of the places.

Jhingaran (1991) the plankton population was closely related to the flow conditions. During low waters tranient in dry season increases the organic materials and algal blooms. But in the period of spates plankton were scanty. According to Allen (1920) turbulance due to high current velocity is very inimical to plankton development. This where flow was showed by other hydraulic forces plankton also developed to a great degree. During the period of flood, plankton presented but were rare, whereas, during the dry season the bloom form with in the standing water and also in the river channel.

The water current plays an important role in fish productivity. This study resemble with Mitra (1968) work that span could not struggle against high current to 0.4 Km./hrs.

Chemical Factors

Hydrogen-ion Concentration (pH)

The pH of water is defined as the logarithm of the reciprocal of hydrogen ion concentration. It indicates the acidic or alkaline nature of water. It is an important chamical factor to measure the concentration of hydrogen-ion in natural water by which the suitablilty of the water for drinking purpose and for the boita is assessed. The P^H of natural water is seven. Even small decrease or increase in this changes its nature as acidic or alkaline respectively. Generaly most of the surface water are alkaline in nature with an average pH range of 7.1 to 8.5 Distilled water is weakly dissociated into H^+ and OH^- ions, the product of which at any time is a constant K^W which is equal to 10^{14} moles/litre.

Most Indian rivers have moderate alkaline water (Venkateshwarlu (1986): recent studies by Mitra (1997) on Godavari, Krishna and Tungbhadra showed a pH ranged of 7.2-8.4. IN general, lower pH values have been recorded for water bodies

during rainy season. pH of river water depends upon the amount of carbonates, bicarbonates and carbon-di-oxide, CO_2, bicarbonate buffer system play an important role in protecting river from the harmful effects of chemical acid disharges and in preventing wide fluctuations in pH value.

In the present study the pH value was varied from 7.0 to 8.71 in 2005 where as in 2006 ranged between 7.09 to 8.80. The maximum pH value was found in the month of June and Minimum value was found in the month of January Mean value of pH ranged between 7.30 to 8.03 in 2005 while in 2006, it varied from 7.31 to 8.13 at station-I and II pH value showed minor variation whereas station-IV & III has major in comparision to other stations. Difference is due to confluence of domestic waste, city sewage and muncipal wastes. The impact of pH values which causes water either acidic or alkaline. So the quality of water has great impact on the fertility in this medium.

In the present study It showed significant positive correlation with total alkalinity, T.H, B.O.D., C.O.D., CO_2, Na, K, and M.P.N. and Negative correlation with D.O., PO_4, SO_4, NH_4-N, flouride at some other station.

In this field the various important effects were studied by different workers and recorded pH as given below; Ray et. al. (1966) and Pahwa and Mehrotra (1966) studied the hydrobiological features of river Ganga from Kanpur to Rajmahal and observed the pH of river water in the range from 7.5 to 8.3.

Vass et. al. (1977) studied the Physico-chemical and hydrobiological characteristics of river Jhelum in Kashmir and was found pH varied from 7.0 to 7.6. Swingle (1967) observed that water having a pH of 6.5 to 9.0 are most suitable for fish culture and those having pH values of more than 9.5 is unsuitable because in

the later carbonate is not available whereas fishes die at about pH 11. Acid water reduce the appetite of the fish their growth and tolerance to toxic substances.

The majority of bacteria and other micro organisms are killed by markedly acidic or alkaline conditions and usually flourish best in a fairly natural media. pH was 30% more important than water temperature and 50% more important than dissolved oxygen according to a recent study. pH value has marked effect on the growth of bacteria. Rainy water dissolves the $CaCO_3$ and forms calcium bicarbonate which is a source of CO_2 for green plants.

In the present study Hydrogen-ion concentration was noticed higher than the permissible limit, but it was found during flood only which showed illeffects on the fishes and aquatic biota, besides it was not suitable for the drinking purpose. The present work is in conformity with other studies conducted by Singh et. al. (1990), Agrawal (1993), Doctor et. al. (1998).

Total Alkalinity (T.A.)

Alkalinity in natural water is due to free hydroxy lion and hydrolysis of salts. Its Quantitative capacity of total alkalinity is to neutralize a strong acid to a designated pH. Total alkalinity is the buffering capacity of water. Alkalinity is an important factor of water to assess its water quality. It is mainly caused by the cations of Ca, Mg, Na, K, NH_4 combined either as bicarbonates or carbonates or hydroxides. Natural water bodies show a wide range of fluctuation in total alkalinities value depending upon basin, season, nature of bottom and plankton population etc.

Phosphates and silicates are rarely found in natural supplies in concentrations significant in the home. Compounds containing these ions may be used in a variety of water treatment processes. Moderate concentrations of alkalinity are desirable

in most water supplies to balance the corrosive effects of acidity. However, excesive quantities cause a number of problems.

Strongly alkaline waters have an objectionable "Soda" taste. The EPA Secondary Drinking Water Regulations limit alkalinity only in terms of total dissolved solids (500 ppm) and to some extent by the limitation on pH.

Highly mineralized alkaline waters also cause excessive drying of the skin due to the fact that they tend to fremove normal skin oils.

In the study of total alkalinity it varied from 210 mg/l to 278 mg/l in 2005 whereas in 2006 it was found between 213 mg/l to 282 mg/l with a mean value of 225.25 to 241.75 mg/l in 2005 and 226.50 to 240.75 mg/l in 2006. The maximum value of alkalinity was found at St. III & IV in month of June where as the minimum value was observed at St. I in the month of August.

Several other methods of water treatment will remove alkalinity. Lime softening removes hardness. At the same time, this process will precipitate an equivalent amount of alkalinity. Lime softening is usually restricted to industrial and municipal installations.

Lime Softening while reducing total alkalinity, lime softening does convert HCO_3^- to CO_3^{--}, a stronger alkalinity ion.

Troublesome amounts of alkalinity can be removed by reverse osmosis, along with other total dissolved solids.

During the present study alkalinity showed singnificant positive correlation with pH, total hardness, calcium hardness, Magnisium hardness, BOD, COD, CO_2, NH_4, Na, K, and negative correlation with D.O. fluoridse. These correlations showed

the effect of T.A. in river water due to domestic wastes, sewage discharges which enhance the level of alkalinity in river water. Alikunhi (1957) reported that in highly productive waters, the alkalinity to be over 100 ppm. Swingle (1967) stated that such a classification of suitability of waters for fish culture many rivers falls within the total alkalinity value equivalent to 10-50 ppm $CaCo_3$.

Alkalinity measurement is also important in controlling water and waste water treatment process. The ratio of alkalinity to that of alkaline earth metal is a good parameter determining the suitability of the irrigation waters. Vess et. al. (1977) found alkalinity of river Jhelum in the range of 22.0 to 94.0 mg/l.

Total Hardness (T.H.)

It is an important factor of natural water. It is mainly caused due to saluble calcium and Magnisium Salts present in the water. So the hardness is frequently used as an assessment of the quality of water. It is water that has a high mineral content (contrast with soft water). Hard water usually consists of calcium (Ca^{2+}), magnesium (Mg^{2+}) ions, and possibly other dissolved compounds such as bicarbonates and sulfates. Calcium usually enters the water aseither calcium carbonate ($CaCO_3$), in the form of limestone and chalk, or calcium sulfate ($CaSO_4$), in the form of other mineral deposits. The predominant source of magnesium is dolomite ($CaMg(CO_3)_2$). Hard water is generally not harmful.

The simplest way to determine the hardness of water is the lather/froth test: soap or toothpaste, when agitated, lathers easily in soft water but not in hard water. More exact measurements of hardness can be obtained through a wet titration. The total water hardness (including both $Ca^{2+}$and Mg^{2+}ions) is read as parts per million or weight/volume (mg/L) of calcium carbonate ($CaCO_3$) in the water. Although water hardness usually only measures the total concentrations of calcium and magnesium

(the two most prevalent, divalent metal ions), iron, aluminium, and manganese may also be present at elevated levels in some geographical locations.

Soft waters originate in areas whereas top soil is thin and limestone formations are sparse and the hard waters originate in areas where the top soil is thick and limestone formation are present. For plant and animal assimilation, Calcium sulfate and chloride when present in water donot serve as effective buffers for storate of CO_2.

In the present study the value of hardness in the river water varied from 150 to 230 mg/l in 2005 whereas it varied between 150 to 240 mg/l. The mean value was found from 172.83 to 189.25 in 2005 and in 2006. It was found between 159.58 to 191.25 mg/l the highest value observed at station III in the month of June and Lowest value observed in the month of August in the study of period. The W.H.O. has set its desirable limit to be 100 mg/l, according to limit of W.H.O. the water is soft and above from this range it was hard. While BIS has set its desirable limit for drinking purposes to be 300mg/l and the permissible limit for hardness is 600 mg/l in the absence of any other alternative source. It was directly affected by alkalinity and pH of river. Ajmal et. al. (1985) found that higher value of hardness were recorded during summer in the study of river Kalinadi.

In the entire study course total hardness showed positive correlation with pH, Cl, total alkalinity, CaH, MgH, B.O.D., C.O.D, CO_2, NH_4, Na, K and negative correlation with turbidity, D.O. fluoride, M.P.N. The significant variations were found in summer and post monsoon. The above factors effect total hardness in river water due to more dilution, Ca precipitation in high pH, sewage discharge.

The present findings resemble with the observation of Shukla (1996) who observed the hardness value between 96.0 and 170.0 mg/l., 90.6 and 160.0 mg/l

and 80.0 and 180.0 mg/l in river Betwa. Upadhyay (1997) Studied Kaliasote dam and found the total hardness in range of 30.0 to 178.0 mg/l. Doctor et. al. (1998) investigated the river Bhadar and registered total hardness in the range of 120.0 to 448.0 mg/l. The variations of the total hardness assesses by above workers marked that hardness is affected by pH and total alkalinity.

The W.H.O. says, "There does not appear to be any convincing evidence that water hardness causes adverse health effects in human. Some studies have shown a weak inverse relationship between water hardness and cardiovascular disease in men, up to a level of 170 mg. Calcium carbonate per litre of water.

Calcium Hardness (Ca.H)

Calcium hardness plays an important role to determining the hardness of natural water to suitability for domestic uses and development of aquatic biota of river water. It is a major component of water-higher pH reduced the concentration of calcium due to its precipitation as calcium carbonate. Calcium is useful in the maintenance of Cytoplasmic membrane and in the wall structure of algae.

In the course of study the Ca hardness of river water ranged between 20.0 to 60.0 mg/l in 2005 and in 2006, it varied from 22.0 to 70.0 mg/l. The maximum value was recorded at station IV and next to it at st. III in the month of June and Minimum value was found in the month of August. The mean value of it was varied from 37.37 to 41.13 mg/l in 2005 and 38.42 to 42.34 mg/l in 2006. The significant increase of calcium hardness was found in summer due to evaporation and less dilution of water. Verma (1993) reported the calcium hardness between 42.0 and 233.0 mg/l in river Betwa.

Calcium hardness showed positive correlation with pH total alkalinity, total hardness, Cl, CO_2, B.O.D., COD, Na, K, SO_4 and negative correlation with D.O.,

turbidity and M.P.N. BIS recommended desirable value of Ca as 75 mg/l in drinking water and its permissible value has been prescribed to be 200 mg/l in the absence of any other alternative. The above factors affect the Ca hardness in water due to evaporation. high pH washing activities etc.

Upadhyay et. al. (1982) reported calcium hardness in the range of 17.0 to 48.0 mg/l in rivers of Kathmandu valley. Calcium as such has no hazardous effects on human health. In fact, It is one of the important nutrients required by the organisms. The concentration upto 100 mg/l of calcium is capable of forming the scales in pipe and boiler. High concentrations of calcium are not desirable in washing, laundering and bathing owning to its suppression of formation of lather with soap. Soap is wasted when trying to form lather, and in the process, scum forms. It coagulates with soap and makes dirty layer on sinks, tubes, pipes, etc. Under these circumstances the utility of water decreases in breweries.

A water softner works on the principle of cation or ion exchange in which ions of the hardness minerals are cxchanged for sodium or Potassium ions, effectively reducing the concentration of hardness minerals to tolerable levels.

It is the precise mixture of minerals dissolved in the water, together with the water's P^H and temperature that determines the behaviour of the hardness, a single number scale does not adequately describe hardness. Descriptions of hardness correspond roughly with ranges of mineral concentrations.

* Soft : 0-20 Mg/l as Calcium
* Moderately Soft : 20-40 mg/l as Calcium
* Slightly hard : 40-60 mg/l as Calcium
* Moderately hard : 60-8 mg/l as Calcium
* Hard : 80-120 mg/l as Calcium

*	Very hard : 120 mg/l as Calcium

In Mandakini river the water is moderately hard.

The variations of the Ca hardness observed by above workers marked it that the value of calcium was always found to be more than magnesium. Shukla (1996) recorded Calcium hardness varied between 54 and 114 mg/l in river Betwa. Verma (1993) found the Calcium hardness between 42 to 233 mg/l in river Betwa.

Magnesium Hardness (Mg.H)

It is an important factor, occurs in all kinds of natural water with calcium. But its concentration remains generally lower than calcium, Mg Hydroxide is practically insoluble in comparison to calcium hydroxide. High concentration of Magnesium combined with sulphate and acts as Laxative to human and aquatic organisms. The concentration of magnesium also depends upon exchange equilibrium and presence of the ions like sodium.

In the present observation calcium hardness followed the trend of total hardness and varied between 138.0 to 180.0 mg/l in 2005 and 138.0 mg/l to 190.0 mg/l in 2006 at various station I to IV. Observation showed the Mg rich nature of river water. The maximum value of Mg was found at St. III in month of june and minimum was recorded at St. I and III in the month of August in the study period. The mean value of it was varied from 146.58 to 161.92 mg/l in 2005 and 147.17 to 161.75 mg/l in 2006.

The source of it in the natural water is various kinds of rocks. Mg hardness is directly related with ca- hardness. Calcium hardness when divided by total hardness gives magnesium hardness. BIS has set adversible limit of 30 mg/l magnesium in water for drinking use. Whereas a permissible limit of Mg hardness of 100 mg/l in absence of any alternative water source.

Shukla (1996) reported magnesium hardness in the range of 36.0 to 56.0 mg/l in river Betwa. Upadhyay (1997) observed the magnesium hardness of kaliasote dam in range varied between 8.0 and 64.0 mg/l.

Mg hardness showed positive correlationship with Ca hardness, total hardness, total alkalinity, SO_4, Na, K, NH_4-N, Cl, C.O.D., BOD, CO_2 and Negative correlationship with D.O., PO_4, M.P.N.

Above changes were marked by the effect of Mg hardness in water due to sewage discharges, floods and evaporation. It is a constituent of chlorophyl and is an essential requirement for pigment algae of all groups as well as aquatic organism.

The variation of the Mg hardness value reported by above workers marked that Mg hardness is closely direct related with Ca hardness which is in confirming with the present findings. Bhatnagar (1989) found the magnesium hardness in the range of 10.93 to 102.32 mg/l in river Khan.

Chloride (Cl)

It is a very important factor of water. Which is present in the form of sodium chloride, potassium chloride and calcium chloride rich in natural water through dissolution of salt deposits, domestic discharges, sewages and effluents from industries. The concentration changes when plysico chemical and biological process take place in water. A high chloride content has deterious effect on metallic pipes and structure as well as on agriculture crops. The human and animal excreta have high quantity of chlorides along with nitrogenous compounds. Since chloride is set to be accompanied with faecal. Increasing chloride concentration may serve as one of the signals of faecal pollution.

Chloride is one of the most constant components of water. Each of these

sources may result in local contamination of both surface and ground water. This quantity averages about 6 to 15 mg/l chlorides per person per day. High concentrations of it affects the suitability of water. BIS has set desirable limit of chloride to be 250 mg/l for drinking water and 600 mg/l for irrigation purpose. Its above range of chloride water become salty taste and affect the potability of the water.

In the present study chloride concentration was found between 2.0 mg/l to 9.0 mg/l in the year 2005 and in 2006 observed between 1.85 mg/l to 9.10 mg/l. The highest concentration was observed at station I in may during both the years. The lowest value of chloride was observed at station. II & III in the month of August. The mean value of it was found 5.02 to 4.95 mg/l in 2005 and in 2006 it varied between 5.39 to 4.97 mg/l. Higher concentration of chloride at St. I and III were recorded due to influence of human interference and sewage discharge and lowest value was depended the rainy season and temporary flood.

Importance of chloride in natural waters has been studied by several workers Panda and Singh (1997) who observed drinking water quality of port city of paradeep and dound chloride ranged between 11.52 mg/l. Arora et. al. (1970) reported heavy fish mortality in Rihand reservoir due to high free chloride content (62 ppm) discharged from Kanaria industries.

Sahai and Sinha (1969) studied a direct correlation between chloride and water temperature Phyto and zooplankton growth and bottom biota.

During entire study of course chloride showed positive correlation with alkalinity, temp, total hardness BOD, COD, CO_2, NH_4, Na, K, SO_4, M.P.N. whereas negative correlation was marked with D.O, PO_4, and flouride. These changes were

noticed by the effect of Cl in river water due to washing, bathing activities, sewage discharges human faeces.Besides, Cl also showed direct correlationship with Phytoplankton and zooplankton to a great extent.

Dissolved Oxygen (D.O.)

It's concentration in water is one of the most important factor for the maintinance and distribution of biota in aquatic ecosystem.

The main Source of oxygen in water is from the atmosphere, which is received by absorption at the surface layer of the water and also by the photosynthesis. Oxygen is consumed by the respiration of plants and animals, bacterial decomposition of organic matter as well as the chemical oxidation of waste sub-stances. It also plays an important role in the organic cycle of river water. Dissolved oxygen volume in water depends upon concentration of dissolved salts, its temperature and the partial pressure of oxygen in the air in contact with water at the surface.

In the present investigation the river water showed good dissolved oxygen value varying from 4.10 mg/l to 7.95 mg/l in 2005 and in 2006. It varied from 3.0 mg/l to 7.90 mg/l. The maximum level of it was at station III and next to it at station II, in the month of January in the both years and minimum was observed at station. I & IV in month of June. The highest value of D.O. was observed during winter season due to low temperature, low quantity of total coliform, and to much water volume. Which increase the oxygen holding capacity of water, where as lowest level of D.O. is observed in summer season in the month of June due to low water volume, high temperature, and high quantity of zooplankton's and total coliforns putrefaction of oxygen. The mean value of dissolved oxygen during the study period 5.22 to 5.56 mg/l. Singh and Singh also reported (1990) Observed dissolved oxygen in the range of nil to 11.4 mg/l in subernarekha river at Ranchi.

The water quality D.O. is quite an important factor inevaluating the water quality. The dominance of zooplankton over phytoplankton is responsible for depletion of oxygen, because their respiratory demand is relatively more. The dominance of zooplankton and the pollutants discharge by the various drains, are the contributory limiting factors for the low or nil dissolved oxygen values. The concentration of D.O. is also affected by the contamination of animal excreta. Low dissolved oxygen and high carbon-di-oxide which cause fish mortality. The unfavourable effects on the fish life are mainly caused by asphyxiation arising out of low oxygen. Its measurement provides a valuable clue to the metabolic balance of aquatic biota. It directly influences the biomagnification and bio accumulation of the river ecology.

The present work is in confirmity with the findings of Sinha et. al. (1995) who reported dissloved oxygen in the range of 5.18 ppm in summer and 12.9 ppm in winter season in the river saiat Rai Bareli. For inland surface waters, BIS recomended the level of D.O. as > 76.0, 75.0, 4.0 >, 3.0 mg/l under class A to D respectively. The water quality criteria according to C.B.P.C. W.P. (1985) suggest minimum level of dissolved oxygen up to 5 ppm. is suitable for drinking purpose.

In the course of study D.O. showed positive correlation with photo synthesis, produced by flora, whereas dissolved oxygen showed Negative correlation with temperature, turbidity, Cl, B.O.D., C.O.D., CO_2, NH_4-N, PO_4, SO_4, Na, K, MPN and zooplankton's, Phytoplankton density changes are due to variation in D.O.

Srivastava et. al. (1997) analysed the drinking water quality of Agra U.P. and found the D.O. concentration between 3.0 and 8.7 mgt. Baruah et. al. (1995) reported dissolved oxygen between 6.5 and 15.0 mg/l. High D.O. (15.0 mg/l) was observed in monsoon which might have been due to the high flow rate and atmospharic

reoxygenation taking place in river. Sinha et. al. (1995) reported minimum dissolved oxygen in range of 3.18 mg/l in summer and 12.9 mg/l in winter season in the use investigation in river Sai at Rai-Bareli. These above said Variations relation to phytoplankton density where investigation resemble with the findings of the above workers. Besides the potability of water depends upon this factor.

Biochemical Oxidation Demand (B.O.D.)

It is an important factor in which the Demand of oxygen is required by bacteria and other microbes while stabilizing the decompasable organic matter under aerobic conditions. It is a good index of the organic pollution and therefore helps in deciding the suitability of water for consumption. This is an empirical test for the determination of relative oxygen requirements of waste waters, effluents and polluted waters, by which anidea about the external pollution which governs the need for the degree of dilution. On an average basis, the demand for oxygen is proportional to the amount of organic waste to be decomposed aerobically. Bacteria use D.O. during the respiration and nitrification. Thus D.O. depletes whereas B.O.D. increases. It is expressed in terms of amount of dissolved oxygen required in milligrams per litre for stabilizing the biodegradable organic matter by micro-organism of the sample under aerobic conditions in a stated time. B.O.D. has been the most widely used single parameter to determine the pollutional strength of domestic and sewage wastes in terms of the oxygen that they will require if discharged in to natural water courses in which aerobic conditions exists.

In the present study the value of the B.O.D. in the river water varied from 0.05 mg/l to 1.50 mg/l in 2005 and between 0.08 mg/l to 2.15 mg/l in 2006. The maximum value of B.O.D. was noticed in June at station III and next to it higher was at station IV. and minimum value of B.O.D. was observed in August at station II. The

mean value of B.O.D. during the study was recorded 0.18 to 0.21 mg/l. The lower values were recorded in rainy season due to much water level and low decomposition of organic matter. Whereas highest B.O.D. was recorded in summer season due to high temperature, purification of faecal matters, much growth of coliform bacteria and sewage discharges. Besides it was also noticed higher during the flood, which carries decomposed organic matters.

In the present B.O.D. showed significant positive correlation with temperature turbidity, PH, T.A., T.H., Cl., COD, CO_2, NH_4-N, Na, SO_4 and negative correlation with water current, fluoride, and D.O., BIS has set a limit of B.O.D. for inland surface water is 2.0 mg/l. Mandakini river has also this factor within this range. This is because of negligible faecal matter and sewage discharges, whereas in Paisuni is more polluted than Mandakini.

Tripathy et. al. (1990) studied river Nandira and found B.O.D. between 15.0 and 164.0 mg/l. Chandrasekar an et. al. (1997) found the B.O.D. in the range varied between 2.0 and 4.0 mg/l in river Tikara. Singh et. al. (1995) studied the impact of river Varuna on river Ganga and observed the range of B.O.D. between 3.0 and 24.6 mg/l. So, these rivers are very much polluted.

Chemical Oxygen Demand (C.O.D.)

It is a measure of chemically oxidizable organic substance present in an aquatic system. Which is an important parameter for estimating the carbonaceous fraction of the organic matter. C.O.D. is measured in terms of oxidizability of the orgnic matter by chemical oxidants such as potassium permagnate of potassium dichromate. The C.O.D. test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances.

It is interfered by the some factors which influence B.O.D. but both these parameters do not have any corresponding correlation between them. At times it has been reported to show a direct relationship with B.O.D.

In the present investigation C.O.D. value varied from 0.01 to 14.10 mg/l in the year 2005 and in 2006 it ranged between 0.01 mg/l to 14.00 mg/l at different sampling stations. The highest value was observed at Station IV in the month of May. The Lowest value was recorded in the month of August. In both the years lowest value was in rainy season due to dilution of water, low temperature and less density of organic matters and the highest value was observed in summer season at Station III due to high temperature, low water level and much organic concentration. The mean value of C.O.D. varied between 0.01 to 11.33 mg/l in 2005 and in 2006 it ranged from 0.01 to 11.29 mg/l during the study.

The C.O.D. showed positive correlation with temperature, turbidity, p^H, T.A., T.H., B.O.D., CO_2, NH_4, PO_4, SO_4, Na, K, M.P.N. and negative correlationship with dissolved oxygen. The desirable limits of C.O.D. recommended by W.H.O. is 10 mg/l in drinking water. C.O.D. change were noticed the effect in water by various ways, Low water level, much organic matters, high temperature, run off the chemicals from the crop lands, drains and inflow of ground waters.

The C.O.D. values were found always greater from B.O.D. values, indicating toxicity. Its value fluctuated from season to season.

The undermentioned workers also reported C.O.D. in some rivers which are: Tripathy et. al. (1990) who studied the water pollution of river Nardira and reported that C.O.D. varied from 110 to 420 mg/l. Singh et. al. (1999) studied river Damodar and registered C.O.D. in range between 35.0 and 584.0 mg/l. Shukla

(1996) observed the value of C.O.D. in river Betwa, in range of 8.0 to 280.0 mg/l.

Thus the above rivers are more toxic than the river Mandakini.

Ammonical Nitrogen (NH_4-N)

Ammonia is the principal nitrogenous by product of organic decomposition. The most important source of ammonia is the ammonification of organic matter. Nitrogen is found primarily in the form of four different molecules Ammonia (NH_4), Nitrite (NO_2), Nitrate (NO_3) and nitrogen gas. Soluble inorganic, organic and nitrogenous matters are decayed by micro-biological activity with the production of ammonia. The most important inorganic nitrogen compounds in water are nitrate and ammonia, both are important sources of nitrogen for aquatic plant life. Generally, in soil that are not waterlogged, soil N and fertilizer-N, are microbiologically transformed to NH_4 through the process of ammonification.

The presence of Ammonia in the water indicates the sewage pollution is recent and the occurrence of nitrite with ammonia show time has been lapsed since the pollution has occured. If all the nitrogen is present in nitrate form become a long time has been passed after pollution because water has purified itself and all nitrogenous matter has been oxidised.

Nitrogen compound serves as nutrients for aquatic micro organisms and responsible for the eutrophication of river water. Sewage has large quantities of nitrogenous matter. Thus its disposal tends to increase the ammonia content of the waters.

In the present study ammonical nitrogen concentration varied between nil mg/l to .052 mg/l in 2005 and in 2006, its range was found between 0.01 mg/l to 0.55 mg/l. The maximum was observed in June at Station III and next to it at station

IV. Whereas minimum concentration was found in August at Station II & I during the entire study period. The mean value was observed between 0.25 to 0.03 mg/l in 2005 and in 2006 It ranged between 0.04 to 0.07 mg/l.

Upadhyay (1997) also assessed the ammonical nitrogen in the range that varied between nil and 0.99 mg/l in the Kaliasote Dam. The maximum concentration of ammonical nitrogen was observed in summer season due to much decomposition of organic matter, animal exreta, high alkalinity and high temperature. Whereas minimum concentration was noticed in the month of August due to dilution of organic matter by rain water.

So the factors responsible for Amonical Nitrogen given by Upadhyay are similar with the present investigation.

It showed positive correlation with temperature, Turbidity, Cl, B.O.D., C.O.D., CO_2, PO_4, SO_4, Na, K, M.P.N. and Negative correlation with water current and D.O. These have marked effects on NH_4-N in water by various ways and showed impact on correlation as stated above. The upper permissible limit of Ammonical nitrogen for drinking and irrigation water is 1.5 to 5.0 mg/l.. A level of 0.15 mg/l of free ammonia for fish culture has been recommended by BIS. Ammonia plays an important role for algae, growth. Algae bacteria both incorporate ammonia very rapidly. Ammonia in higher concentration is harmfully to fish and other biota It is also toxic to man at higher concentrations.

Having in view be permissible limit it is concluded that river Mandakini is suitable for drinking irrigation and fish culture. Where as Krishnamurthy et. al. (1994) studied the water quality of Kalinadi and found that ammonical nitrogen varied between 0.22 and 0.45 mg/l Sewage pollution in Ooty lake was reported

by Rao et. al. (1994) and confirmed by the presence of high contents of Ammonical nitrogen varied between 0.1 to 8.3 mg/l. These are higher polluted. The present investigation is in confirmity with the work given by Joy et. al. (1990) who studied the river periyar and reported the ammonical nitrogen in range of nil to 0.065 mg/l.

Nitrite-Nitrogen (NO_2-N)

Nitrite is formed in water by oxidation of Ammonium compounds or by reduction of nitrate. In surface water, with sufficient oxygen and high value of oxidising reducing potential, process of bio-chemical oxidation are predominant. Presence of even a small quantity of nitrite may indicate the feacal pollution of the water body and the availability of partially oxidized nitrogenous matter. As an intermediate stage in the nitrogen cycle, nitrite a very unstable ion and appears in the water chiefly as a result of biochemical oxidation of ammonium to NO_3 by two groups of bacteria (Nitrosomonas and Nitrobacteria).

These changes in water were marked by affects of Nitrite in it by various ways viz: Sewage discharges animal excretaa, and decomposition of nitrogenous matter by bacteria. Nitrite may also be produced in distribution system through the activities of micro-organisms on ammonia. The high content of nitrite in water can also cause "Blue baby" disease in infants. Higher ammounts are present in sewage wastes. Especially in biologically purified effluents and in Polluted streams.

In the present study the nitrite value ranged between nil to .025 mg/l in the year 2005 and in 2006 it was .0010 mg/l to .038 mg/l. The maximum value was found at station- II & III in the month of June whereas Miminum value was recorded at station I in the month of August, during the entire study span. The mean Value of No_2 N was observed in river water between 0.0128 to 0.004 mg/l in the year 2005 and in 2006 it varied from 0.0157 to .006 mg/l.

The Nitrite nitrogen showed Positive co-relationship with NH_4-N, No_3-N, CO_2, Cl, PO_4, SO_4, Na, K, M.P.N. and Negative correlation with water current D.O. and Fluoride. Abdul et. al. (1996) found nitrite concentration varied from 0.022 to 0.022 mg/l in Kuttiadi lake BIS and USEPA have not set any standards of nitrite for drinking water. However, USEPA (1997) has prescribed a limit of nitrite and nitrate together to be 10 mg/l. In Mandakini river the concentration of this factories with in the prescribed limit.

The present findings are in conformity with the observations of Chauhan et. al. (1990) who found that the nitrite concentration was from BDL to 0.065 mg/l in Narmada river of Mandla. Upadhyay (1997) reported the concentration of nitrite in range of Nil to 0.469 mg/l in Kaliasote Dam. Rao et. al. (1994) investigated nitrite between 0.01 and 1.23 mg/l which indicates the sewage pollution in Ooty lake. The variation of the No_2-N reported by above workers marked that the value were found corresponding to that of Ammonical nitrogen.

Nitrate (NO_3-N)

It is an important plant nutrient and most oxidized form of Nitrogen. Nitrate usually occurs in trace quantities in surface water. The most important source of the nitrate is biological oxidations of organic nitrogenous substances which come in sewage and domestic wastes the seepage of sewage and runoff from crop lands. Domestic sewage contains very high amount of nitrogenous compounds.

The amount of nitrate nitrogen; in the water bodies have been shown to fluctuate with the seasons. This water quality parameter is related with human health. Human infants have been especially susceptible not only because of their high gastric p^H but also due to their high fluid intake relative to body weight, its poisoning brings "methemoglobinemia" condition which resulting from changes in the hemoglobin

of the red blood cells that reduce their capacity to carry oxygen. Information of change in the concentration of nitrates and the concentration of other nitrogen forms may be used to characterise the rate of process of self purification and the self purifying capacity of the water body.

In the present investigation the concentration of nitrate-nitrogen was 1.00 mg/l to 1.90 mg/l in the first year 2005 and in second year 2006 between 1.02 to1.98 mg/l . The higher volues were recorded at st.III and IV in the month of june where as lower volues were found at st .II & I in the month of augest during the entire study span .the mean value was found from 1.29 to 1.58 mg/l in 2005 and in 2006 it varied between 1.32 to 1.61 mg/l.

It showed distinct seasonal variation. On seasonal basis generally nitrate value showed more concentration in summer and in pre monsoon season due to much excreatory matter, domestic sewage. Whereas less concentration was recorded in August.

BIS has set a desirable limit of nitrate contents in drinking water as 45.0 mg/l and a permissible limit of 100 mg/l in the obsence of any other alternate source. Besides the present findings resemble with the work of Shukla (1996) who also reported the nitrate 0.01 to 1.6 mg/l in monsoon in different bodies of surface water.

The nitrate showed positive correlation with Temperature, pH, T.A. , Cl, B.O.D., C.O.D., CO_2, SO_4, NH_4, Na, K, MPN and Negative correlation with turbidity, water current, and D.O. These impacts were marked by the effects of nitrate nitrogen in water due to decomposition of organic nitrogenous substances, high water temperature, domestic sewage discharges and high excretory matters, High

concentration of nitrates are in water useful for irrigation but their entry into water resources increase the growth of nuisance viz. algae vizalgae and triggers eutrophication.

some researchers also reported this parameter in other rivers i.e. Sharma (1998) who found nitrate in the range of nil to 3.33 mg/l in sewage waters of Gwalior region. Chandrasekaran et. al. (1997) studied Tikara river and found nitrate in range of nil to 0.1 mg/l. Mitra (1997) found the nitrate concentration in the range nil to 55.0 mg/l in river Brahmani. Doctor et. al. (1998) investigated nitrate in between 2.3 to 44.0 mg/l in river Bhadar.

The concentration of NO_3-N reported by above workers was higher than the river Mandakini which infers that the river under study is less polluted than the above said rivers.

Phosphate (PO_4)

Phosphours is one of the major nutrients responsible for Phytoplankton growth which are consumed by zooplankton and later by fishes. Nutrients play an important role in the metabolic activities of the plant and animals. So its role is in water productivity. There is no common atmospheric source for phosphorous. Phosphates are formed mainly during certain biological process of transformation of organic substances to inorganic phosphates. Synthetic detergents, domestic sewage, dead micro organisms, waste water, agriculture run off and run off of water from the catchments areas are the major sources of Phosphorour in water bodies. During the vegetation period, the phosphates of soluble form are readily taken up by aquatic plant organism, mainly phytoplanktons. Considerable irregular increase in the concentration of Phosphate indicates the presence of pollution.

Phosphates are found in all photoautotrophes. where they are synthesized enzymatically and constitute part of phosphate pool. The prime concern of phosphates lies in the ability to increase the growth of nuisance algae and entrophication. Although phasphate is not considered as harmful constituents in drinking water but its presence in even small amount can be harmful in some circumstances and can produce accelerated growth of algae and aquatic vegetation, there by causing eutrophication of the aquatic system, If phosphate were removed it could be made the limiting factor.

In the present study the PO_4 of river water found between .0007 to .048 mg/l in 2005 and in 2006 it ranged between .0017 to .0489 mg/l . The maximum level of Phosphate content was recorded at St. VI in the month of August and minimum concentration was noticed at Station- I in the month of February.

The mean value of Phosphate content ranged between .0027 to .0412 mg/l in 2005 and in 2006, it varied between 0.0036 to 0.0415mg/l. In the present investigation the concentration of Phosphate was recorded high in the rainy season due to storm run off or agriculture run off.

Natural waters having a phosphorous content of more than 0.2 ppm PO_4 are likely to be quite productive whereas excess of PO_4 in surface waters is a sing to heavy organic pollution. BIS and USEPA have not set any standard value for phosphate in drinking water but the critical level for inorganic phosphates has been established 0.005 mg/l. The phosphate showed positive correlation with sulphate T.H., Na, K, and negative correlation with D.O. at most of the monitoring station.

The present observation resemble with the work of Panda & Singh (1997) studied river Mahanadi and reported the Phosphate in the range of 0.38 to 4.0 mg/l. Mahajan et. al. (1995) determined the luxuriant growth of Phytoplankton in Barwani

pond and confirmed the presence of phosphates in the range of 0.1 to 2.2 mg/l because when the concentration of phosphate increased beyond 0.2 mg/l the growth of phytoplankton also increases tremendously. Upadhyay (1997) determined the phosphate in the range varied between ND and 0.563 mg/l in Kaliasote dam. The variation of Phosphate noticed by the above workers and reported that it is a limiting factor.

Sulphate (SO_4)

It is a naturally occurring anion in all kinds of natural water. Sulphate is found in arid and semiarid regions, particularly in higher concentration due to the accumulation of soluble salts in soils and shallow aquifers.

It is an important constituent of hardness with Ca, Mg and impart permanent hardness to the water. Sulphate is also found in water as hydrogen sulphade. In natural waters, H_2O is produced as a result of reduction of sulphates by certain bacteria under an aerobic condition and also as a result of bacterial decomposition of proteins containing reduced sulphus. The supply of sulphate ions in surface, ground and under ground water, under natural conditions is due to the reaction of water with sulphate containing rocks. It is also due to the biochemical and chemical oxidation of sulphide and other compounds of sulphur.

Sulphate content of natural water is an important consideration in determining their suitability for public and industrial supply because of its cathartic effect upon human when it is present in excessive amounts. At higher concentration it causes gastro intestinal irritation when sodium or magnesium is present. Increase in sulphate concentration may be related to the pollution of the water body. Sulphate determination in polluted water. Sewage and industrial effluents are of paramount importance because sulphate is directly associated with odour and corrosion problem.

In the present study the concentration of sulphate was found in range of 0.42 to 3.10 mg/l in the year 2005 and between 1.55 to 3.89 mg/l in 2006 at different sampling stations. The highest value was observed at St. IV in the month of June and Lowest value observed in Rainy season in the month of August at Station I & II. The mean value was observed between 2.08 to 2.21 mg/l in 2005 whereas in 2006 it was found between 2.07 to 2.28 mg/l . Highest value was found in summer season primarily due to decomposition of organic wastes and discharges of sewage and lowest value was found in mansoon season mainly due to much dilution and much water volume.

BIS has set the limit of sulphate in drinking water to be 200 mg/l, where as its permissible limit is 400 mg/l in the absence of any other alternative source. The sulphate showed positive correlation with temperature pH, T.A., T.H., Cl, BOD., COD, CO_2, PO_4, Na, K and negative correlation with turbidity, water current, and D.O. These change were marked by the effects of SO_4 in water.

The present work is in conformity with the finding of Sharma (1998) observed the sewage water in Gwalior region and found sulphate in range of nil to 1.749 m.eg. Raju et. al. (1999) studied Pulang river basin and registered sulphate in a range of 5.0 to 100.0 mg/l. Singh (1999) who recorded the sulphate value in the range of 0.021 to 10.960 in Narmada river.

Sodium (Na)

It is one of the most abundant elements occurring in nature. In natural waters, the major source of sodium, is weathering of various rocks. And it found in the form of Halide (Nacl) $Na_2B_4O_7$ and sodium sulphate. Concentration of Na in natural fresh water is generally lower than the calcium and magnesium. It is an importent element but high concentration of sodium is harmful to human physiology. Sea

water is especially rich in this element due to which sea water is unsuitable for most of the human requirements such as drinking, domestic, irrigation or industrial uses. According to Hedge and Kale (1995), Na in irrigation water is a problem due to its affects on soil structure, infiltration and permeability rates.

The ratio of sodium to total cations is important in agriculture as well as human pathology. It is essential to sustain biological life. The BIS who has prescribed a limit of 200 mg/l of Na for suitable water. A high percentage of exchangeable sodium in a dispersion restricts water movement and affects plant growth. During natural softening of water, sodium salts are highly soluble in water and much more objectionable than are the salts of calcium and magnesium because of the tendency of sodium to cause deflocculation of the collodial fraction of the soil and to develop an undesirable structure. Na is exchanged by Ca^{++} and Mg^{++} and thus gets increased in concentration in some ground waters. High concentration of sodium associated with chlorides and sulphate make the water salty and randers it unpotable. Lower concentration of sodium water can be used for the irrigation on most of the crops with very little danger of accumulation of sodium at the harmful level.

In the course of study the sodium of river water varried between 6.0 mg/l to 39.13 mg/l in 2005 and in 2006 it fluctuated between 7.0 to 40.00 mg/l. The highest value was found at St. III in month of August and lower was found at St. II and next to it was lowest at St. I in the month of January in the entire study span. The mean value was observed between 18.35 to 33.63 mg/l in 2005 and 17.96 to 33.73 mg/l in 2006. Highest value recorded in rainy season due to more drainage of domestic waste and sewage discharges run off from nalas are rich in sodium and increase its concentration of natural waters whereas lowest was found in winter season due to less discharges etc. Na showed positive correlation with tem., pH, T.A., Cl, BOD,

C.O.D., CO_2, NH_4, PO_4, SO_4, M.P.N. and negative correlationship with D.O. These changes were marked by effects of sodium concentration in water.

Mitra (1997) studied river Brahmani and observed sodium 5.2 to 48.0 mg/l. Mitra (1995) found sodium in the range varied from 11.5 to 49.3 mg/l in tributaries of Mahanadi. Agrawal (1993) found the sodium in the range of 6.0 to 160 mg/l in river Betwa from Nayapura to Vidisha.

Potassium (K)

It is an important cation occurring naturally. The major source in natural fresh water is weathering of the rocks. The concentration remain quite lower than the sodium, magnesium and calcium. It plays a vital role in the metabolism of fresh water environment and acts as an enzyme activator. Potassium also enters the exchange equilibra of the observed cations.

It is a necessary requirement for all algae, under low potassium concentration, growth and photosynthesis of algae are poor and respiration high. The quantities increase in the polluted water due to disposal of waste waters, like sodium. Das et. al. (1992) reported potassium fluctuation between 1.6 and 6.3 p.p.m. in river Brahmaputra.

In the present study the value of potasium in river water varied between 1.50 to 30.12 mg/l in 2005 and ranged between 1.70 to 38.12 mg/l in 2006. The maximum value was found at station-IV in the month of August highest value was recorded in rainy season due to leaching from soil, sewage wates etc. The minimum value was recorded at station-I in month of January. Lowest was found in winter season due to low concentration of organic wastes in discharges and also low temperature. The mean values was observed in range of 6.32 to 6.56 mg/l.

C.O.D., CO_2 ,NH_4, PO_4, SO_4, M.P.N. and negative correlationship with D.O. These changes were marked by effects of sodium concentration in water.

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The Potassium showed positive correlation with temperature, turbidity, pH, T.A., T.H., Cl, BOD, COD, NH_4, Na and negative correlation with D.O. & SO_4, at some stations. These changes were marked by affects of varied concentration in discharges. Sodium is not very much significant from the health point of view but large quantities may be laxative. BIS, has not set any standard of it for drinking water.

The observations resemble to the findings of Agarwal (1993) who investigated the potassium in range between 10 and 28 mg/l in river Betwa. Mitra (1997) studied the hydrology of river Brahamani and reported the potassium in range of 1.3 to 52.5 mg/l. Upadhayay (1997) found the Potassium in range of Nil to 6.0 mg/l in Kaliasote Dam. Sharma (1998) determined the Potassium Nil to 0.225 mg/l in sewage waters of Gwalior region.

Carbon-di-oxide (CO_2)

It is an important factor for the assessment of water quality. It is mainly derived from the organic carboneous matter in rivers which comes from dead or living animals and plants, sewage discharge wastes and soil erosion. They are oxidized by aerobic bacteria in the presence of dissolved oxygen and carbon-di-oxide. CO_2 in natural water is derived from the atmosphere, respiration of animals and plants in night, Seeping ground water and combined with basic elements chiefly calcium, magnesium and sodium and it forms corbonates and bicarbonates. it is highly water soluble compound. Low concentration of CO_2 in the surface water is due to its utilization in Photosynthesis and is carried out only by green plant containing chlorophyll in the presene of sun light, in this process O_2 is formed. Whereas in dark or nights high concentration of carbon-di-oxide is found because plants and aquatic organisms continue respiration. Oxygen being taken up and CO_2 is given

off. The high CO_2 contents appears to be more toxic in the presence of low oxygen contents Welch (1952). Hutchinson (1957) explaind that the study of CO_2 is quite important to understand the hydrogen-ion concentration of water.

In the present study the CO_2 of river water varied from 1.40 to 4.40 mg/l in 2005 and in 2006 its values fluctuated between 1.60 to 5.80 mg/l. Highest value was found in summer season in month of June at station III and II due to nalas sewage high decomposition of organic matter and animal excreta at high temperature and respiration of planktons heavy influx of discharges and leaching of soil in river whereas lowest value of CO_2 recorded in winter season in the month of January at station-I and II due to low decomposition of organic matter. Low temperature and much water quantity. The mean value of CO_2 ranged between 2.42 to 3.17 mg/l in 2005 and in 2006 it varied from 2.62 to 3.31 mg/l.

The Carbon-di-oxide showed positive correlation with temperature, T.A., Cl, T.H, B.O.D., C.O.D., NH_4-N, PO_4, SO_4, Na, K and M.P.N. and negative correlation with D.O. These changes were marked by various factors, which increased CO_2 concentration thus CO_2 showed positive correlation with above factors and negative correlation with D.O.. In the rainy season some CO_2 gets dissolved in rain water which contains about 0.6 mg/l of dissolved oxygen also. Besides, atmosphere furnishes some CO_2 to natural waters by direct contact. High CO_2 contents of natural waters being more toxic to fish and indicates water pollution. The presence or absence of free CO_2 in the surface water is majorly regulated due to utilization by algae during photosynthesis and also through its diffusion from air. Sreenivasan (1974).

The present work coincide with the findings of Jhingaran (1991) concentration of free CO_2 being detrimental to fry and fingerlings of major carps

under varions combinations of temperature and oxygen. Ellis, M.M. (1973) considers that the concentration of free CO_2 should not exceeds 3 ml/l and that any higher value usually indicates pollution. Gardner, T.A. (1926) report on the respiratory exchange in fresh water fish with suggestions as to further investigations. CO_2 concentration is not found high in Mandakini river.

Fluoride (F)

Fluoride is the most electro negative and reactive element. It is considered as a serious pollutant and its toxicity is harmful to aquatic biology as well as potability of water. Fluoride exists either as inorganic fluorides or organic fluorided compounds. Major natural source of flourid in environment is natural weathering of rock and increasing in the atmosphere due to various industrial effluents, leaching or chemical fertilizer from croplands iron, steel plants, phosphate fertilize units, coal powering etc.

1.0 P.P. m concentration has been recommended with a permissible operating range of 0.8 to 1.2 P.P.m mottling of the teeth or enamel fluorsis occurs. Higher level of fluoride in drinking water has been reported to cause various physiological orders in human beings as well as aquatic animals. In the present investigation fluoride concentration was noticed higher than the possible limit which showed effects on the aquatic biota along with fishes, beside it was also not suitable for the drinking purpose.

In the present study the fluoride of river water varied between .05 to .49 mg/l in 2005 and in 2006 it varied between nil to .50 mg/l. The highest value was recorded at station III in the month of September. The maximum value was found in rainy season due to floods which carry more chemical elements from adjoing areas. Whereas the lower value was found at station II in the month of July. The mean

value was recorded in the range of 0.17 to 0.34 mg/l in 2005 and in 2006 it varied between 0.26 to 0.35 mg/l. fluoride is within the Permissible limit therefore it is not ill effects causes.

It showed positive correlation with temprature, turbidity CO_2, NH_4, Na, K, and negative correlationship with pH, T.A., Cl, D.O., B.O.D., C.O.D., SO_4, at some stations, these changes were marked by effects of varied concentration in discharges fluoride.

The present work is in conformity with the findings of Chinoy, N.J. (1991) who studied effect of fluorides on Physiology of animals and human beings. Tripathi, M. and Tripathi, A. (2005) stated the fluoride is a pollutant which interferes with growth of fish and affects fish production. Sharma, P.D. (2000) who reported fluoride ranks 6^{th} in order of priority of different pollutants.

The variations of the fluorid noticed by above workers and reported that it is a limiting factor.

Biological Factors

This factors includes Total coliform M.P.N. Phanktones (Phytoplankton and zooplankton), aquatic weeds and economically important fishes which are discussed as under:-

Total Coliform (M.P.N.)

Bacteria of the coliform group are considered as excellent indicator of faecal pollution and it is for that reason they are widely used as indicator of water quality. Coliform organism are found in the intestine of many vertebrates. The origin of these micro organisms has been generally the result of surface run off precipitation that carries micro organisms attached to dust particles to earth or by addition of

waste water to water ways, Lakes which carry organic matter. Hence bacterial community of water represents the environmental conditions.

Bacteriological examination of water has a special significance in pollution studies, as it is a direct measurment of deleterious affects and is a cause of pollution which is hazardour for human health. The presence of bacteria is deteted in faecal matters. Thus it is indicative of sewage contamination. When faecal pollution is found the water is considered to be potentially dangerous to health. River waters are contaminated by sewage and other pollutants containing several bacteria capable of causing diseases such as typhoid, fever, dysentery, diarrhoea, and cholera. All bacteria require phosphate which is utilized by growing organisms almost as fast as it is made available.

In aquatic ecosystem of bacterial communities considered as indicators of eutrofication as well as water pollution and high count in water is harmful for drinking and bathing purposes.

This test is reliable for the quality of any water supply as well as it shows deleterious affects of population on human health. and identification of in crop organisms. W.H.O. has set a desirable limit of coliform is zero number/10ml in drinking water. The actual number of coliform is difficult to report therefore they are reported as an approximate count most probable number.

In the present study MPN of coliform organism fluctuated from 58 to 1600/ 100 ml. in the year in 2005 and between 55 to 1789.0/100 ml in 2006 at different sampling station. The minimum concentration was found in the month of January at station-I in both the years while maximum was recorded at station-IV in the month of August. The highest value of M.P.N. was noticed in summer and monsoon period

by the entrant of run off water from cultivated crop land and organic matters by areas and by leaching of soil. Next to it in summer due to much of purification of organic matters domestic, sewage discharges in low water volume with low water current and high temperature. On the basis of the permissible limit of coliform bacteria for patable water the water of river Mandakani was assested as polluted one.

Total coliform showed significant positive correlation with temperature. Turbidity, and T.A., Cl, B.O.D., C.O.D., CO_2, NH_4-N, PO_4, Na, K, and negative correlation with T.H., D.O., SO_4, these relationships were marked by the density of total coliform which are related with the quantity of organic matters disposal.

The coliforni load in river water indicates that bacteria are always and under all conditions remain in water body. Bacterological investigation in river water have been carried out by Doctor et. al. (1998) noticed MPN between 300/100 ml to 1600/100 ml in river Bhandar. Different workers have used different bacteria consentration to assess the quality of water. The Present work is in confermetly with the workes give by the above workers.

Plankton

The biological properties of various rivers have been investigated time to time humerous limnology in India and abroad. Algae flora are the autotrophic organisms which make substantial contribution towards the primary productivity in a water ecosystem and occupy the base level in energy transfer within the natural ecosystem.

It plays an important role in trophic relationship as they are consumed by a number of fishes. Every water body has microflora and found in the forms of Phyto

and zooplankton and Their density varies according to the nature of water.Quantitative and qualitative estimation of Phyto and zooplankton is required to study an aquatic environment unplanned and rapid increase in the pollution sources an leading awareness has been developed regarding the role which these organissm play in ecology of polluted waters (Lickens, 1972). In ecological units, algae are the main primary producers and serve as good tools for the assessment of toxicity in water body.

Phytoplankton (Micro flora)

Seasonal bloom of phytoplankton provided various colours as green, blue, grey, yellow in water. Algae have the principal growth products of eutrofication. Their importance is improving food for herbivorous fishes and also in releasing oxygen by Photosynthesis and thus increases D.O. in water.

Phytoplankton density also revealed a positive correlation with some important Physico-chemical properties such as D.O., Nitrate, Phosphate & Sulphate at all the sampling sites, however, all these properties except D.O. showed negative correlation at site IV. B.O.D. and C.O.D. indicated a negative correlation with phytoplankton density at all the sites. This may be due to high concentration of undesirable substances.

In the present study phytoplankton were observed qualitatively and quantitatively which belongs to the group of chlorophyceae, Bacillariophyceae and cyanophyceae (Mixophyceae) Phytoplankton of the river in generally composed of awide variety of forms that are the greatly affected by surrounding environment. Discharge of sewage wastes drastically change the quality of water the consiquently the composition of Phytoplankton.

Group A : Chlorophyceae

In Mandakini river water, the chlorophyceae group varied from 17 org/l to 154 org./l in 2005 where as in 2006 it ranged between 11 mg/l to 169 org/l, it was abundant during summer and then in rainy season, its density was lesser in the winter season. These variations were noticed as a summer season due to much concentration of nutrients, low amount of water, high temperature, pH and high photosynthesis due to high radiation of sun. But in second year its density was lesser in rainy season due to floods which cause turbidity diluation of nutrients, high water current turbidity which retards the photosynthetic activity due to hindrance of radiation. Their impact is directly on the growth of the chlorophyceae.

During the present study there was a gradual rise in the population of chlarophyceae from February on wards and touched a peak level in April to July work.

Jha (1982) and Tiwari (1983) have reported primary maxima during summer, Secondary during winters and lowest during monsoon. Munawar (1974) has recorded an increased phytoplankton population in sewage contaminated rivers and ponds, according to him the density of phytoplankton population at peak development during summer and minimum in rains. During the course of study period chloro phyceal group was dominated over rest of the phytoplankton population.

Bacillariophyceae

The aquatic forms are both fresh water and marine. Generally the diatoms are yellow brown, golden-yellow or olive green. The colour is due either to the presence of a very large proportion of the carotenoids or to the presence of an accessory brown pigment called the diatoms. They constitute an important part of the fresh water or marine plankton which forms the basic food of the aquatic animals.

In the present observation their range was 03 to 114 org/l in 2005 while in 2006 it was recorded 04 to 102 org/l during seasonal variations. They grow quite during winter season. The maximum density was noticed due to low water temperature, medium water current and pH presence of organic wastes which stimulate the growth of diatoms while lowest concentration was found due to dilution of nutrients, strong water current and turbidity. The lowest density was recorded in the rainy season. Sluggish current of summer associated with maxim undiatoms population also supports the above view. Hence the works are in resemblance the present works. High turbidity produces an injurious blanketing effect on the phytoplankton and kill them (Welch, 1952, Roy 1955 and Chakrabarty et. al. (1959).

The present observation are in confirmity with the findings of Jha (1982) and Tiwari (1983) have also recorded thin phytoplankton population during rains. A direct relationship of temperature with diatoms population was recorded by Sharma and Pant (1979). Rishi (1983), strong current velocity resulted in low plankton population. In river Bhagirath too, the maximum phytoplankton population was observed when turbidity and current velocity were low (Sharma, 1985). During the entire study period Melosira was most dominant genus of diatoms whereas, Cymbell appeared as the second dominant genus of Bacillariophyceae. In the present study the summer month (May and June) peak of diatoms were noticed.

Group C : Cyanophyceae

These are useful for phytosynthetic ability, chemotrophio and hetrotrophice capabilities. Blue green algae were the second dominant group are phytoplanktonic community. These marked at all stations mostly in summer when pollution was high. It includes the blue green algae which are the only brown oxygen producing prokaryotes. Many filamentous blue greens possess specialized cells of disputed

function known as the heterocyst. According to Rai and Kumar (1977) observed that high nutrient concentration was required for peak development of cynophyceae. High temperature and cyanophyceae are directly correlated. (chakrabarti, Laxminarayanan, Rishi and Tiwari).

In the course of study it varied 16 to 332 org/l in the year of 2005 and in 2006 ranged between 36 to 344 org/l. The abundance of blue greens during summer season rise in the population from February and touched a peak level in April to June. Microcystis was most dominent member of blue green algae.

High alkalinity and buffering capacity resulted in growth of blue green algae. During the study high level of ammonical nitrogen and organic matter were found more which are responsible for growth of blue green algae. The abundance of blue greens are due to high temperature, pH, dissolved organic matter phosphate nitrogen and relatively high values of dissolved oxygen during the study rich phosphate and silicate coupled with moderate nitrogen contents were responsible for high blue greens yields in summer and winter season.

The present study resemble with the work of above workers. The blue green algae furnish food for fish and other aquatic animals. Blue greens are capable of utilizing first of all ammonical nitrogen directly.

Blue green algae is able to use bicarbonate more effeciently than other species of algae thereby enabling them to photosynthesise at lower CO_2 concentration resulting in more carbonate during their abundance (King, 1970; Shaprio, 1984). Blue green are chief agents for nitrogen fixation in rice fields. So it is very good organic fertilizers. Philipose (1959) who stated that fresh water phytoplankton of Inland fisheries.

It is showed from the above discussion that the blue green algae were found at all stations with low qualitative and quantitative observations in comparison of chlorophyceae and bacillariophyeae having high temperature, much concentrations of phosphate and ammonia nitrogen with low D.O. condition. Chakrabarty et. al. (1959) reported a quantitative study of the plankton and the physico-chemical conditions of the river Jamuna a study of fresh water.

Zooplankton (Micro fauna)

These are the primary consumers in the food chain and they feed on phytoplankton. Which occupy the central position between the autotrophs and hetrotrophs and form an important link in aquatic food web, these are used as food by some plankton feeder fishes. In fresh waters there are dominated by cladocera, Copepods, and Rotifers, exhibit diurnal vertical migration. and they are important in fisheries. Zooplanktons are preferred by fry as they are easily digested.

Lall et. al. (1986) pointed out that poor density of zooplankton and abiotic factor indicate oligotrophic condition. Singh and Singh (1985) stated that zooplankton favour less light and moderate temperature and directly related with D.O. Schluter and Groeneweg (1981) stated that reducing D.O. concentration through high organic loading was found to be infective because many zooplanktons are able to survive extended period of anoxia through physiological tolerance.

In the present zooplankton study their various groups were observed as protozoa were estimated qualitatively and 7 Genera were found their density was also recorded which was from 02 org/l to 92 org/l. in 2005 whereas in 2006 it ranged between 01 to 105 org/l.

It was observed that density was minimum in rainy season in subsequantely increased and reached at the maximum in summer. Their maximum number were

found at station II in the month of June which was due to much decomposition of organic matter and high temperature by which more nitrates were produced. Thus protozoan showed a direct relationship with nitrate constants and D.O. Pokkie, (1968) reported that Protozoans increased gradually from spring to summer but in winter it was sporadic. So the above work is an comfermtly.

Rotifera were observed 5 genera where mostly found in summer season. They were noticed in the range of 04 to 87 org/l in 2005 whereas in 2006 they ranged from 05 to 87 org/l Their maximum number were found in the month of June which was due to more concentrated organic discharge by sewage. Pirozhnikov, and Shulga (1957) stated that basic characteristics of the zooplankton of the lower river Lena. Rotifers correlated with higher alkalinity and temperature condition, (Michael, 1964).

In crustaceans, copepoda and cladoceran each were observed in which 5 and 6 genera, were copepode, they varied between 09 to 79 org/l in 2005 and in 2006 ranged between 09 to 83 org/l, whereas cladoceran ranged from 04 to 85 org/l in 2005 while 03 to 100 org/l in 2006. Cladocerans and copepods were maximum in month of May due to high turbidity and high temperature much decomposition of sewage discharges with the result alkalanity. Copepode and cladocerans indicate the incidence of organic pollution (Anthony et. al.).

In the present study the summer peak of zooplankton might be due to high temperature, Higher pH, nitrate contents, alkalinity and some other important nutrients which stimulate the reproduction and favored the development of zooplanktons population in the river. So, obviously the pollution is increased.

The present work is in conformity with the observation of O' Brien and De Noyells (1972) who reported that pH values of 10.5 to 11.0 were total to

zooplankton in naturally entropic pond. George et. al. emphasized that temperature is the single most critical environmental factor controlling the reproduction of zooplankton. Besides the various groups of zooplankton variation recorded in this work also resemble the works of different workers as stated above.

Aquatic Weeds (Macro flora)

Aquatic weeds are undesirable plants which grow in water: Their excessive growth prevent effective utilization of water and reduce productivity. These are mostly aquatic angiosperms in the form of free floating, submerged and marginal weeds. The leaves of the free floating weeds are floating on the surface of the water and roots are hanging underneath. Enchorial, Lemna, Marselia, Spirodella are the free floating weeds. Submerged weeds grow under the water surface and may or may not be rooted viz: Hydrolyle vallisneria, Potamoget, certatophyllum, Ninjas, mancer. Whereas mariginal weeds were much number observed in river Mandakini due to it is shallow nature.

According to Muencher (1944) stated that aquatic plants are those species which normally stand in water and must grow for at least a part of their life cycle in water, either completely submerge or emerged.

The human activities spot on the rivers cause heavily infected with a variety of aquatic weeds which make interference to the religions ablution of the pilgrim. (Dutta and Gupta, 1976) As aquatic weeds grow in water due to rich phosphorus and ammoniacal nitrogen, they reach in water through the sewage and run-off and human faces water pollution & simultaneously water. borne diseases and also they check free movement of the fishes and make oxygen depletion and accumulation of CO_2. Gases like hydrogen sulphides and methane are formed which are harmful to the fishes. Accompanying economical losses to the fish farmers, traders, public too.

In the present study period 2005 to 2006, it was observed that the free floating species of aquatic weeds, Lemna, Paucicostata, Eichhornia, Crassipes, Azolla species, and floating level species were Nymphoides cristatum were found. Flowering and fruiting of Lemna, sprrodella were seen from January to May their flowers are enclosed in a membranous spathe with in the reproductive pouch while enchoria which is known as water hyacinth which in habit near river banks, polls and canals because of its luxuriant growth. They Lateron cover the entire surface of the water and thus chocks water courses and greatly hamper navigation and fishing. The seeds germinate during the rainy seasons and they bear flowers in sept. and Oct. The seed remain dormant from November to June Nymphoides are small plants with floating leaves. It usually flowers and fruits in winter seasons from oct to Feb. These free floating forms predominate and their colonies are found at such places where river forms side pools at station - I, II and III. Potamogeton pectinatus and potamogeton perforliatus are aquatic herbs with a stont dichotomously branched stems and their flowering and fruiting were observed through out the year. Chara and Nitella spp. form sub aquatic meadows in the marshy and shallow channels at station II and III. Otellia spp. is rarely seen totally submerged but is found at shallowest part of the river.

Thus it was marked that during their growth period the colonies of cannected rosettes of Trapa spp. are usually sun cultivated along the river by the local inhabitants.

Submerged and floating level form maximum coverage and pure as well as mixed association in deeper parts of the river. Occasionally Naujas, Hydrilla and vallisneria also grow in pure formations or in a mixed occurrence of all the three. They lack cutile, stomata and roots and are completely adopted to an aquatic mode of life. Hydrilla flowers during winter season from October to January is eaten by

some fishes and as it is a goods oxygenator Vallisnenia flowering and fruiting from Oct. to March Chopra et. al. (1956) reported that it is used as a stomachic and folleucorrhola. Hydrilla and vallishenia are also cultivates in aquaria mostly these plants are also used as manure. So these aquatic plants are benifecial for the biota.

It is a shallow river in comparison of river Ken and other rivers. As the shallow rivers are favorable for the excessaive growth of aquatic weed as it was observed in river Mandakini. In this river the growth of aquatic weeds were found more during the study period. Besides the canal nalas, excessive growth of aquatic weeds was also observed in the small water pockets around the river. During the flood period drift of weeds in the river proliferates and caused weed infestation near by river bank, weed infestation is a very big problem in the river.

Abundance of macrovegetation appear with the arrival of rainy season. A large amount of minerals and organic matter are discharged in to the river from the near by are as including domestic sewage and increases the fertility of the bottom soil. Discharge of raw domestic sewage and other wastes are also responsible for the enrichment of minral in bottom soil. This soil causes the luxuriant growth of weeds. Weeds decay material enhance the fertility of the bed. Its management can be made by taking measures such as leaching of ammonical nitrogen, phosphate and good manure can be obtained by composting the weeds in pits which is utilized for agricultural lands as fertilizers.

Fish Fauna (Macro fauna)

Fishes constitute economically a very important group of vertebrate and they play important role of food chain in water. Fishes are the main resources of proenious food, their growth, reproduction and production depend upon water quality. They are a major component of most aquatic habitats and water pollution

affects all aquatic organism including fishes Suitable water has a fair amount of dissolved oxygen. Sufficient amount of nitrate phosphate sulphate, carbonates, organic compounds as well as planktons besides temperature variation, light, pH and water flow, their optimum values are required for fish biology, number of the rivers are polluted which adversely affect all aquatic organisms including fish growth, domestic waste, sewage discharges and industrial effluents are causing pollution of water. The waste products and discharges of sewage extremely change the physical & chemical properties of river water, these changes caused depletion of fish population and other aquatic biota Thus they are the primary indicator for nature of water.

Zoological survey of India (1991) has published that about 400 spp of fishes of India. Fishes and birds are very large in number than other vertebrate obviously these are numerous genera and species of fresh water fishes besides their multiplication productivity is also very high verious ichthologists have reported fishes, Gunther (1880) recorded 26 families of fishes in India. According to Day (1985) observed 87 genera in India fresh water.

Fishes are economically important of fish culture as a source of food production was then driven home more realistically and emphasis was laid on the need for extending fish culture activities to all the parts of the country with a view to developing the industry on scientific lines, both in the private and public sectors (Jhingren, 1991).

Besides being used as food, Fish diet provide rich protein, fats and vitamins A,D & E phosphorous and other elements are also present in it. Fishes are easily digestable fish oil is also important fishery by product. They are used as fish manure for fields which contains a high percentage of nitrogen and phosphate, fish meal is an important artificial food for poultry, pig and cattles.

The skin of many fishes are used for making polishing and smoothing material. Fishes provide several useful by products by which fish industries are developed. These are also used in fish glue, isinglass artifical pearl industry sports and games and many other products of commerce. So the fishes and their by products are very usefully used for various pourpose.

In the course study it is found that various economically valued fishes and nill stream fishes are present in river Mandakini in which 14 families, 28 genera and 33 species were investigated in river Mandakini. A number of economic important fishes were seen during the study period in (2005 to 2006). Labeo rohita, L. calbasu, cirrihinus mrigala, catla catla, Mystus seghla, Wallaga attu, Heteropheustes fossilis, Channa panctatus, Mastacembelus, Armatus and they were more abundant in river Mandakini but less than deep rivers.

The bed of this river is composed of fine brown and the banks of the river has muddy with vegetation at some places. The river which is in upstream canal is more shallow than others station, A less number of fishes were found at upstream canal where the river is more shallow than others station. whereas station II which is Sphatikshilla and station III Jankikund have more fishes than all the selected stations due to enrichment of nutrients, deepness of river and vast water level for the fish movement.

The fish fauna of Mandakini is characteristics in having a large number of fishes, but the water is not suitable for drinking pourpose due to discharges in river.

Atomospherice Temperature (^{0}C)

year- 2005

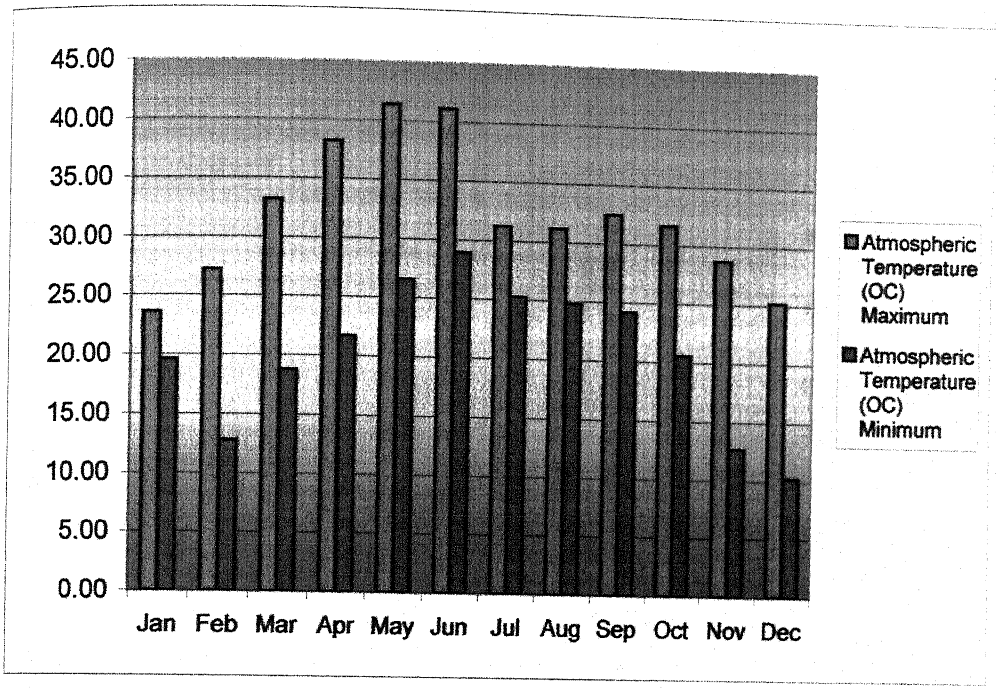


Fig-1

Year- 2006

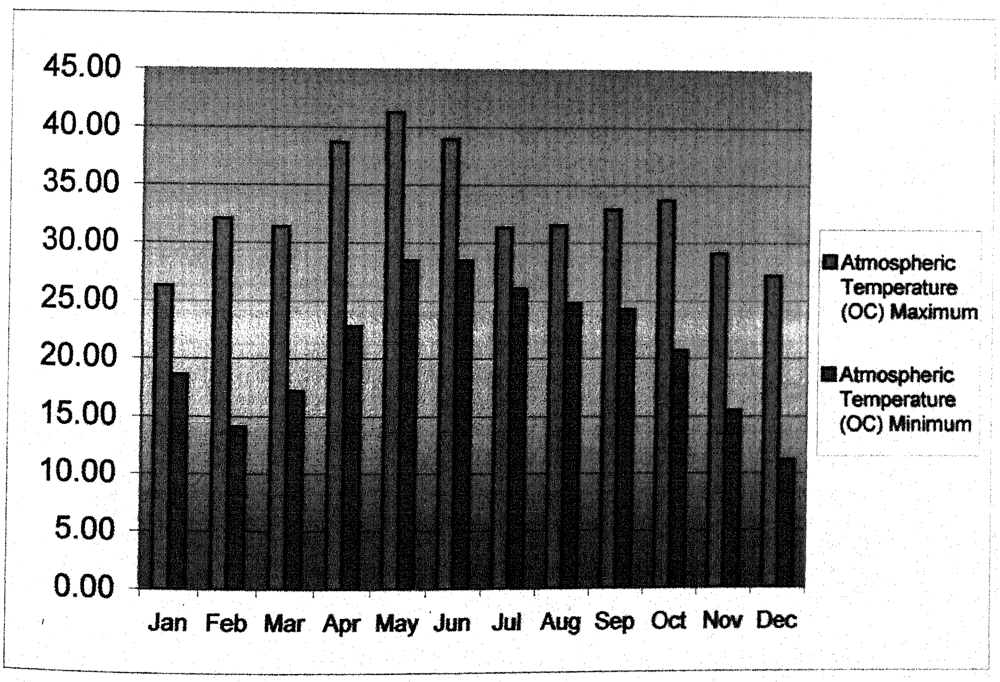


Fig-2

Relative Humidity (%), Rain Fall (mm) & Photo Period (Hrs.)

Year- 2005

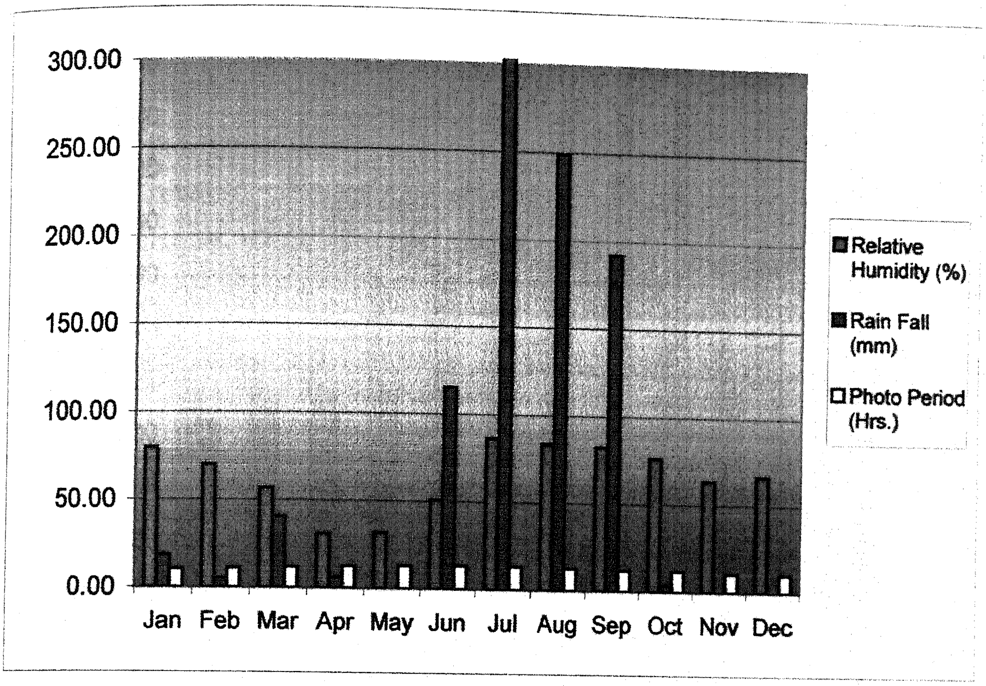


Fig-3

Year- 2006

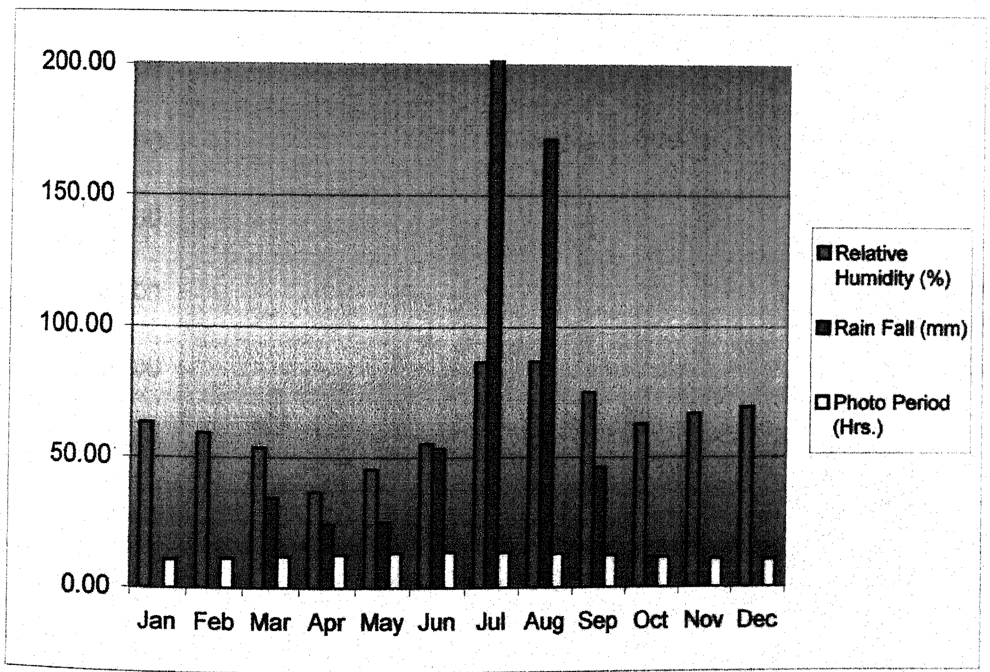


Fig-4

Water Temperaute (^{O}C), Turdidity (N.T.U.) & Chloride (mg/l)

Station No. 1

Year- 2005

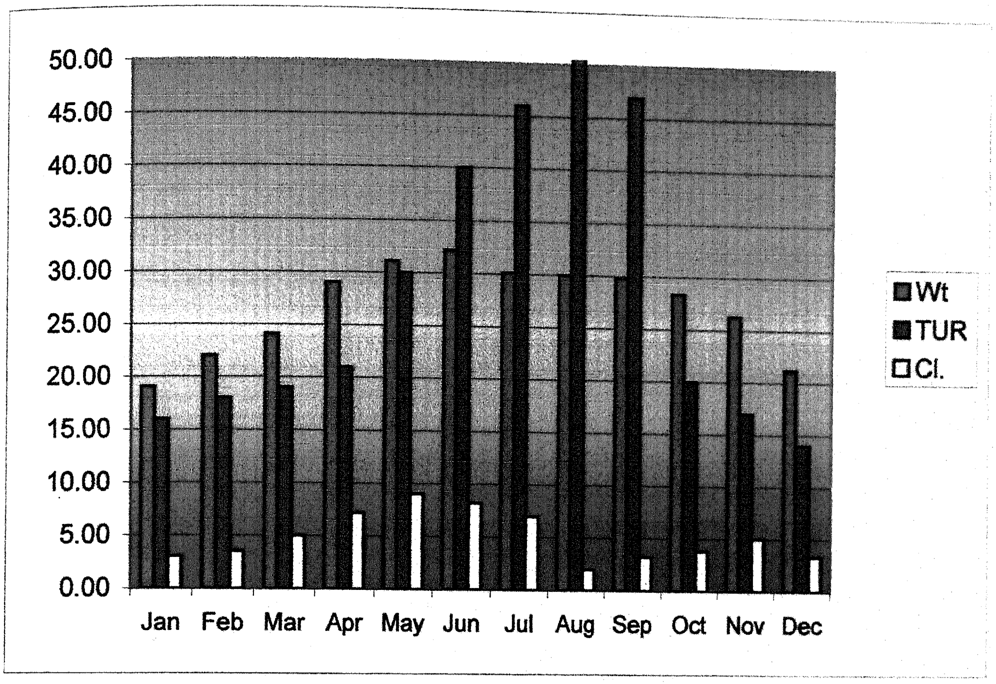


Fig-5

Station No. 2

Year- 2005

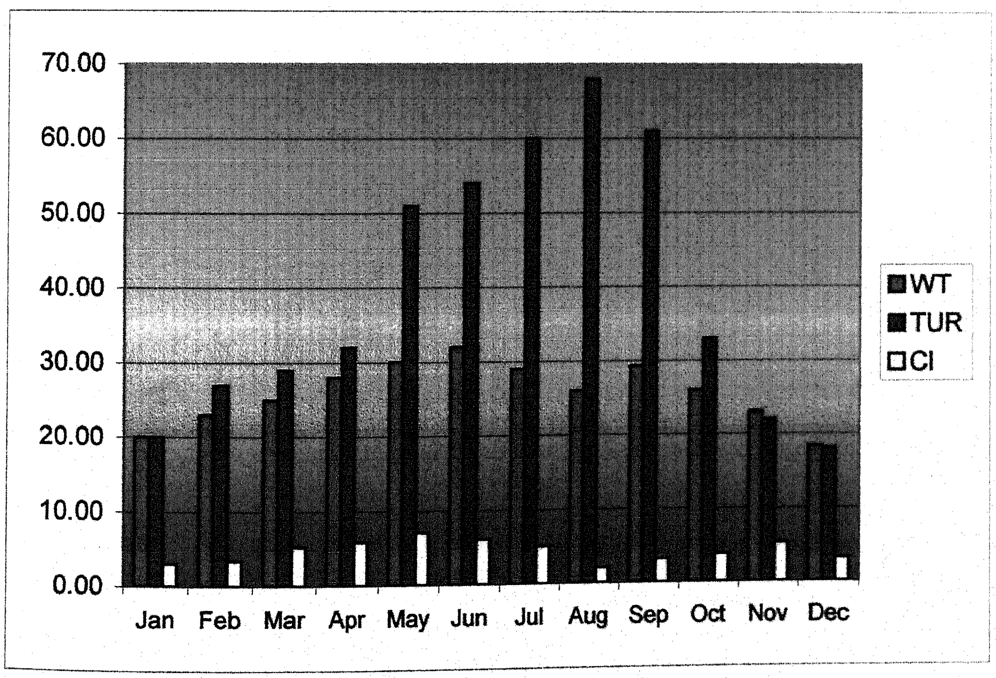


Fig-6

Water Temperaute (^{O}C), Turdidity (N.T.U.) & Chloride (mg/l)

Station No. 3

Year- 2005

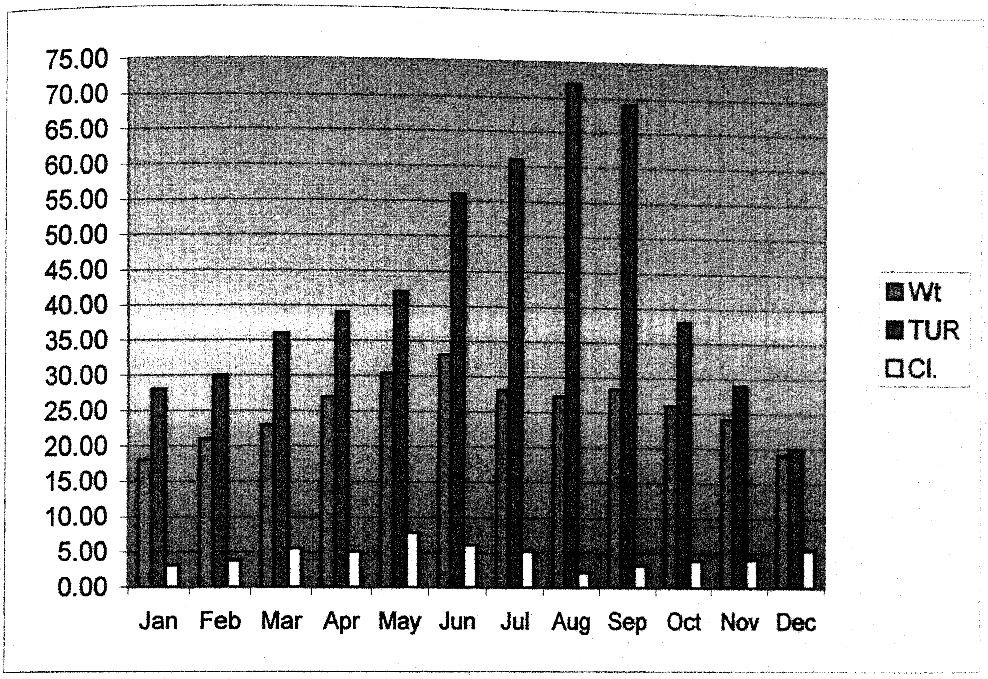


Fig-7

Station No. 4

Year- 2005

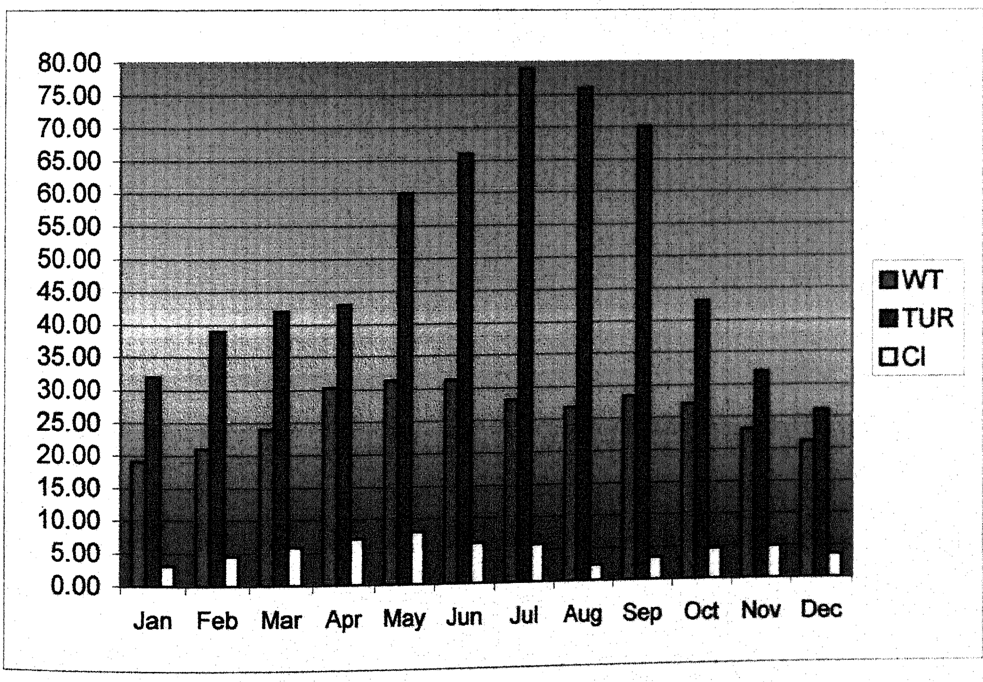


Fig-8

Water Temperaute (^{O}C), Turdidity (N.T.U.) & Chloride (mg/l)

Station No. 1

Year- 2006

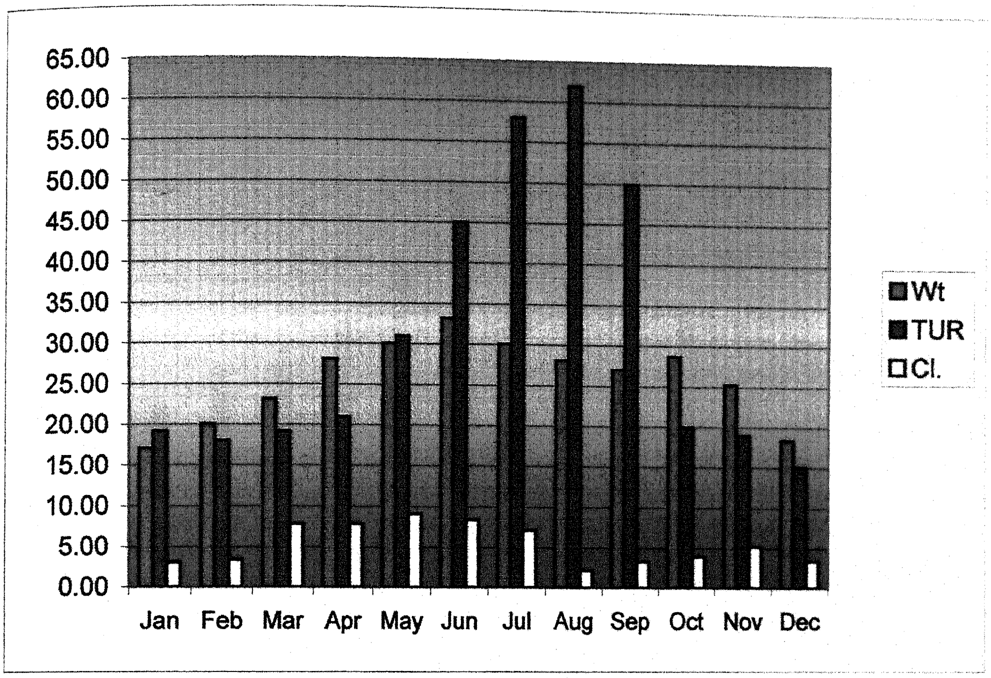


Fig- 9

Station No. 2

Year- 2006

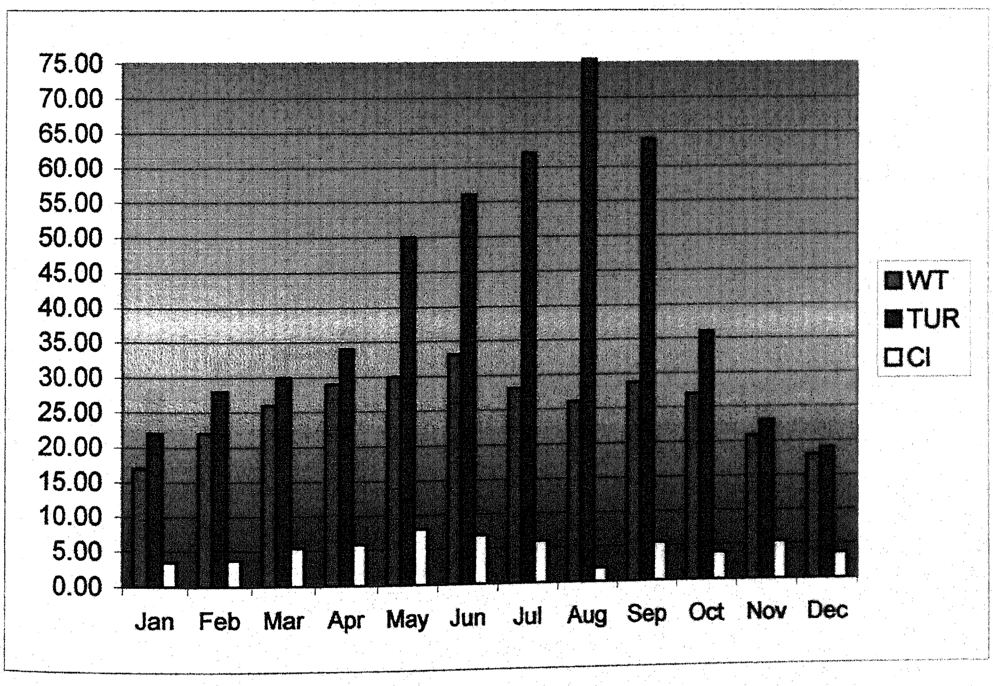


Fig-10

Water Temperaute (^{O}C), Turdidity (N.T.U.) & Chloride (mg/l)

Station No. 3

Year- 2006

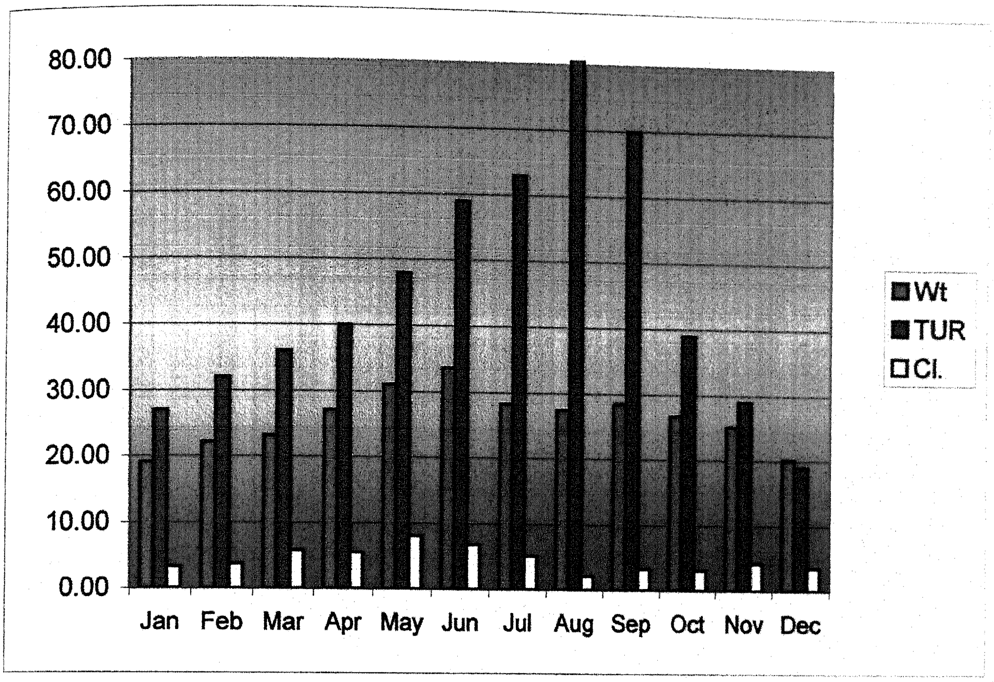


Fig-11

Station No. 4

Year- 2006

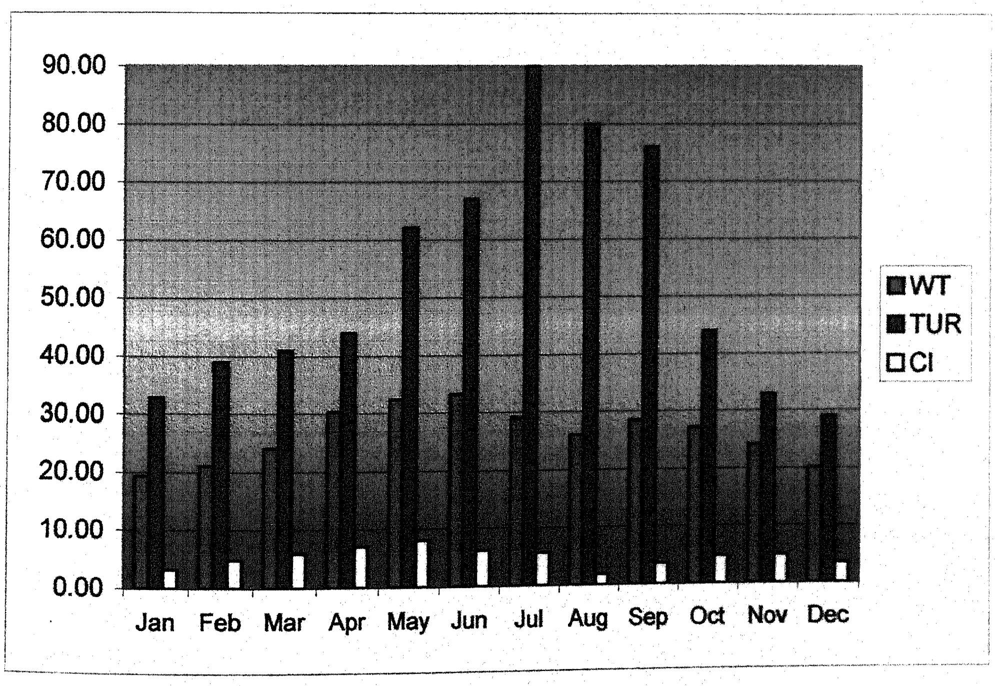


Fig-12

Hydrogan ion-concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

Station No. 1 **Year- 2005**

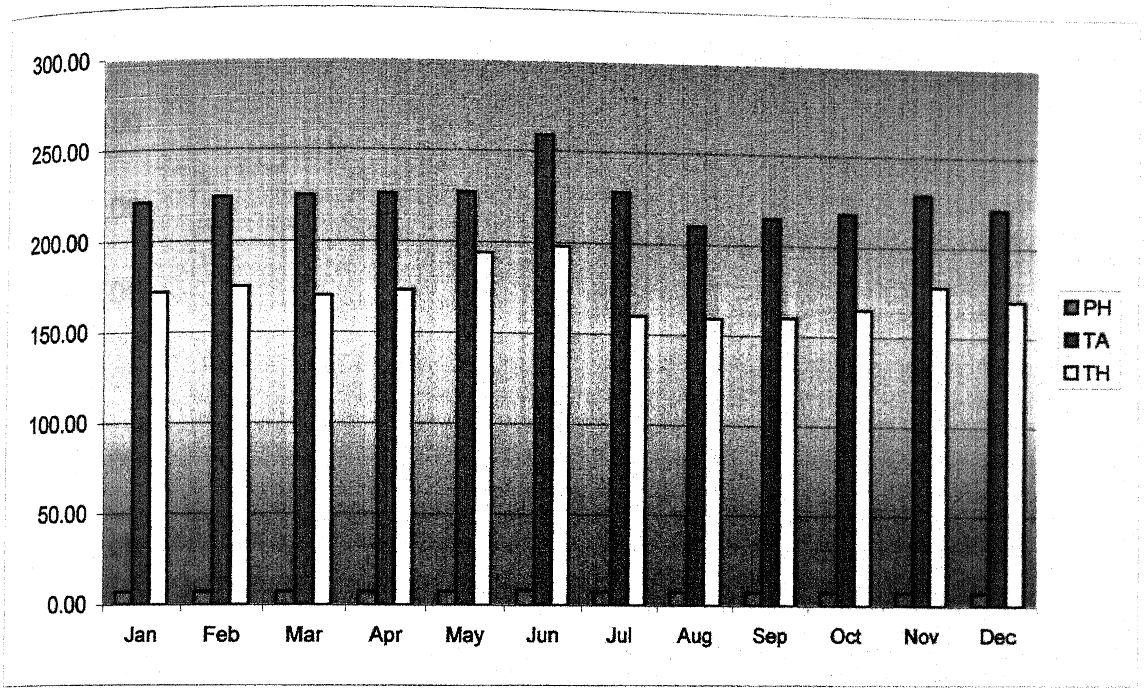


Fig-13

Station No. 2 **Year- 2005**

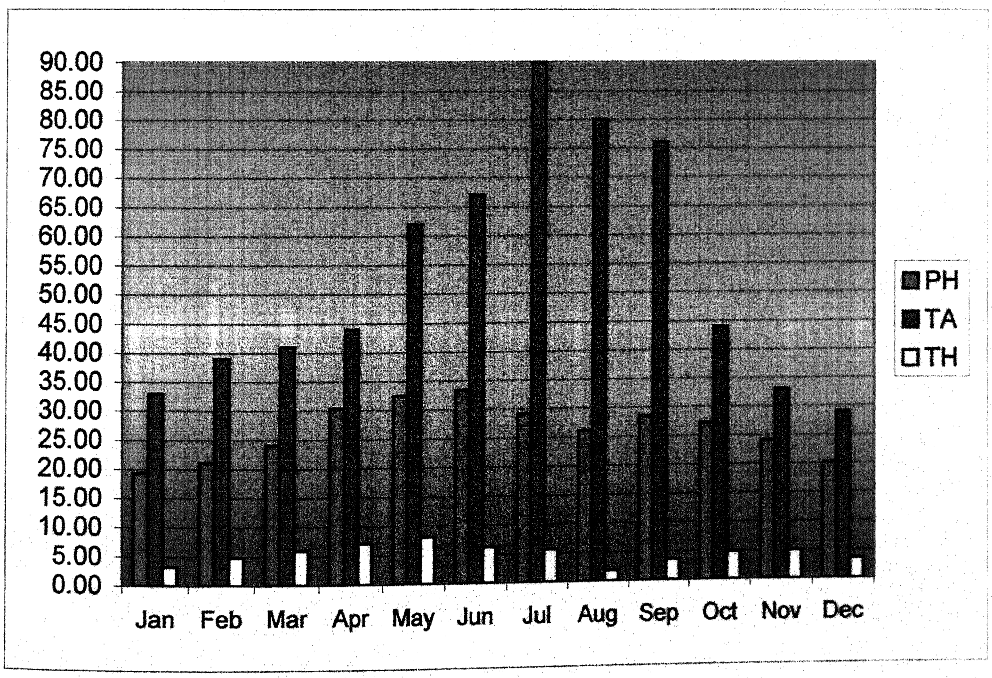


Fig-14

Hydrogan ion-concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

Station No. 3 **Year- 2005**

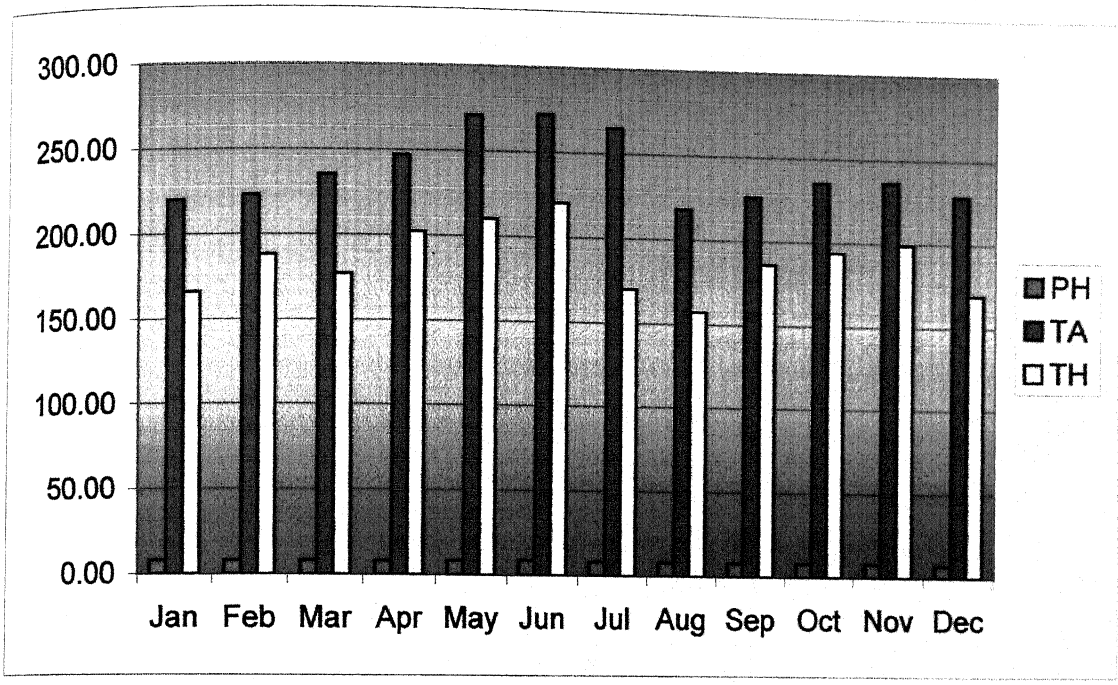


Fig-15

Station No. 4 **Year- 2005**

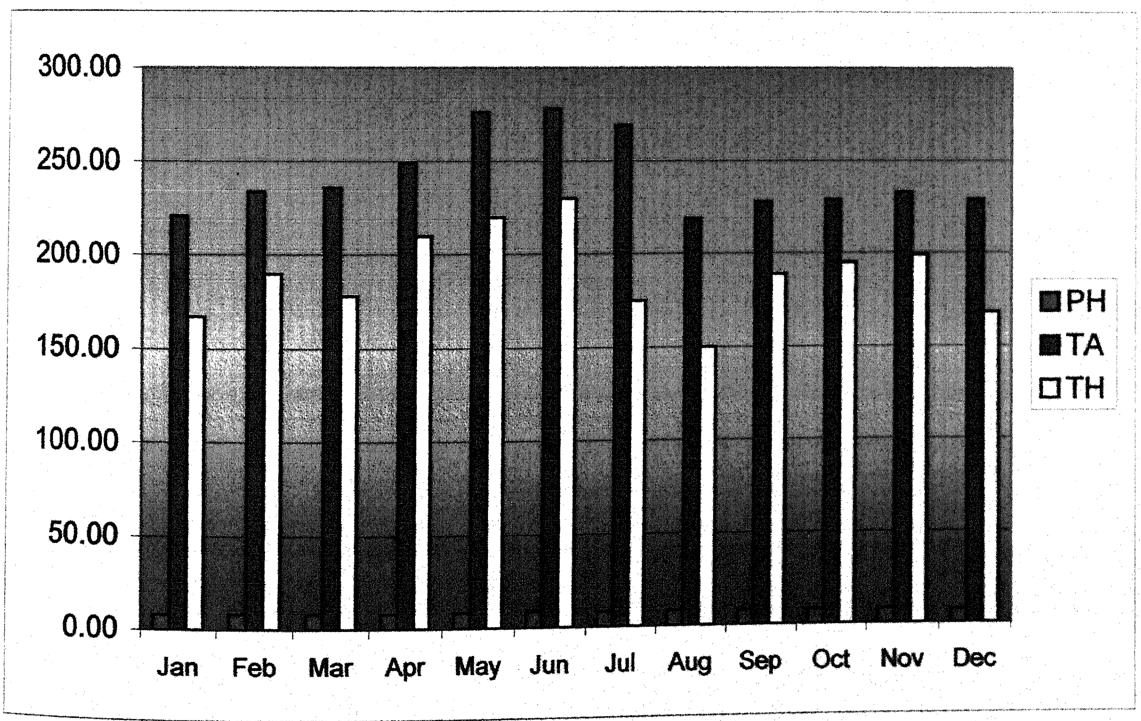


Fig-16

Hydrogan ion-concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

Station No. 1

Year- 2006

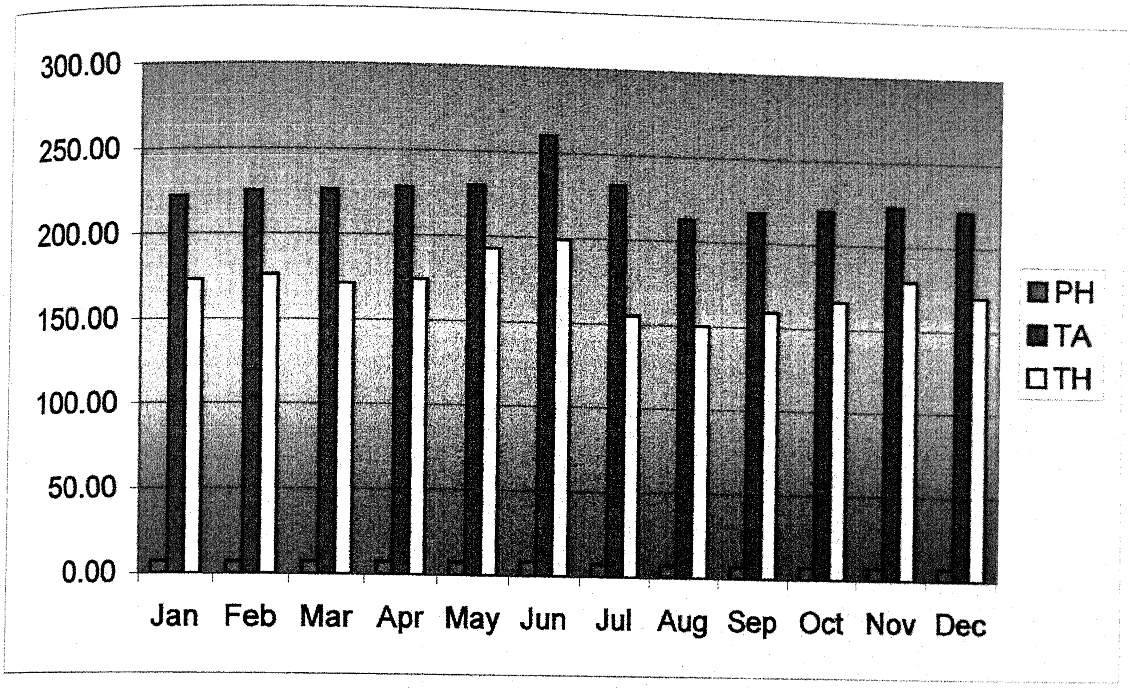


Fig-17

Station No. 2

Year- 2006

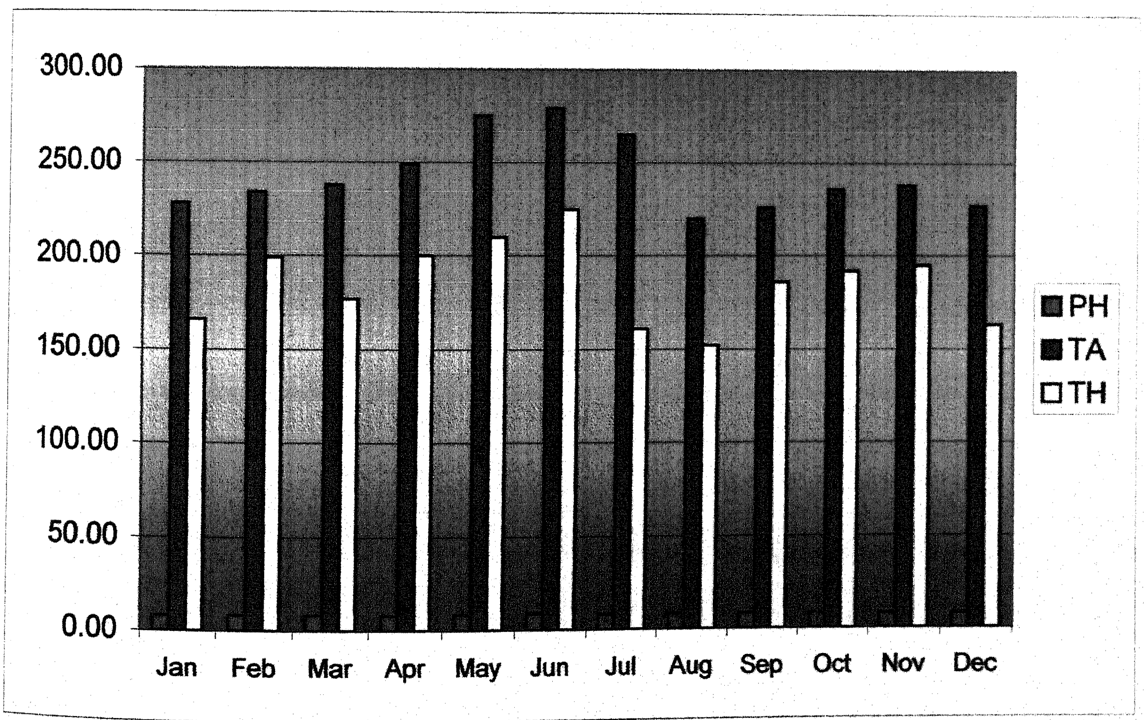


Fig-18

Hydrogan ion-concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

Station No. 3

Year- 2006

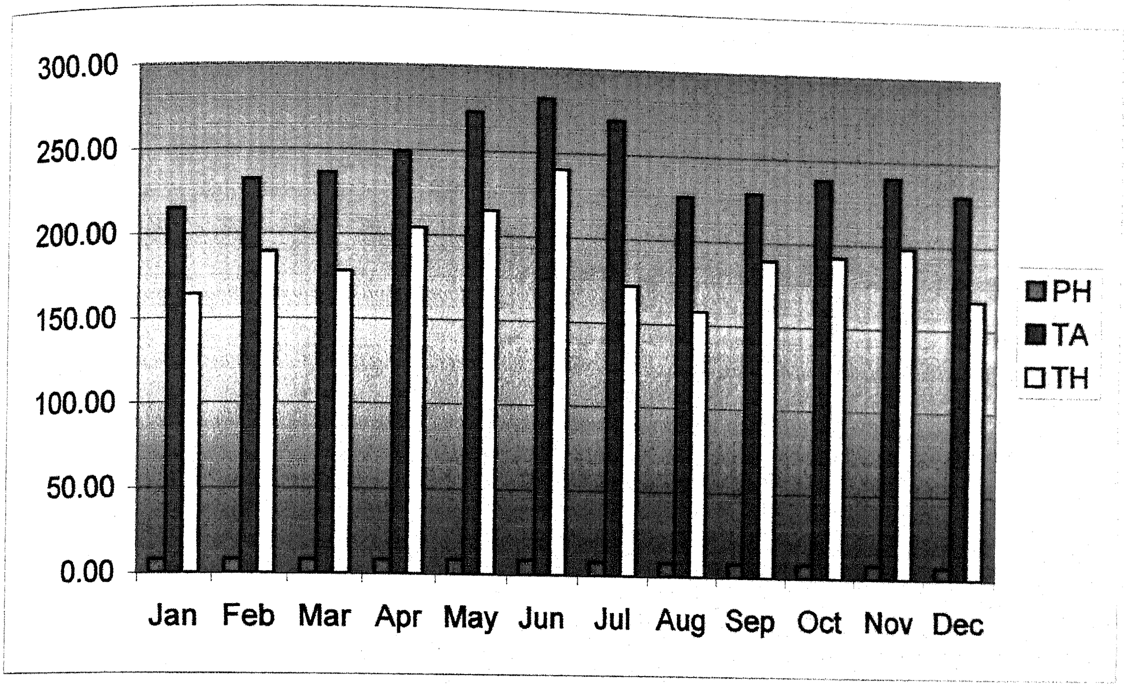


Fig-19

Station No. 3

Year- 2006

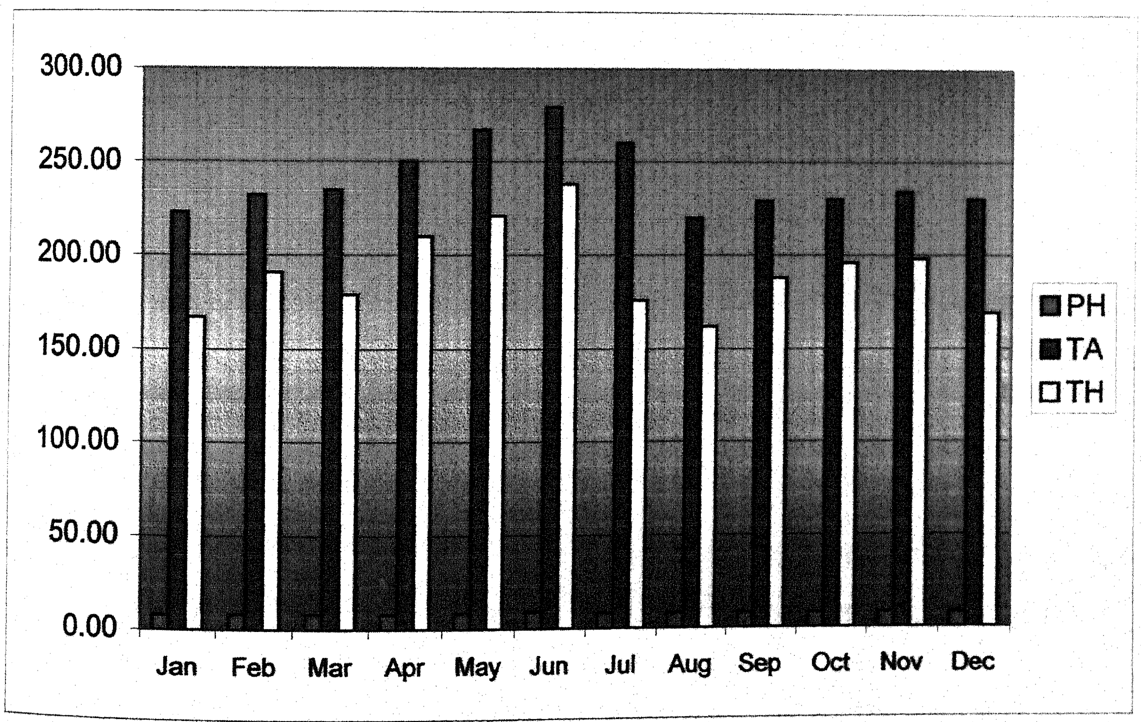


Fig-20

Total Hardness (T.H.) Calcium Hardness (Ca.H.) & Magnesium Hardness (Mg.H.)

Station No. 1 **Year- 2005**

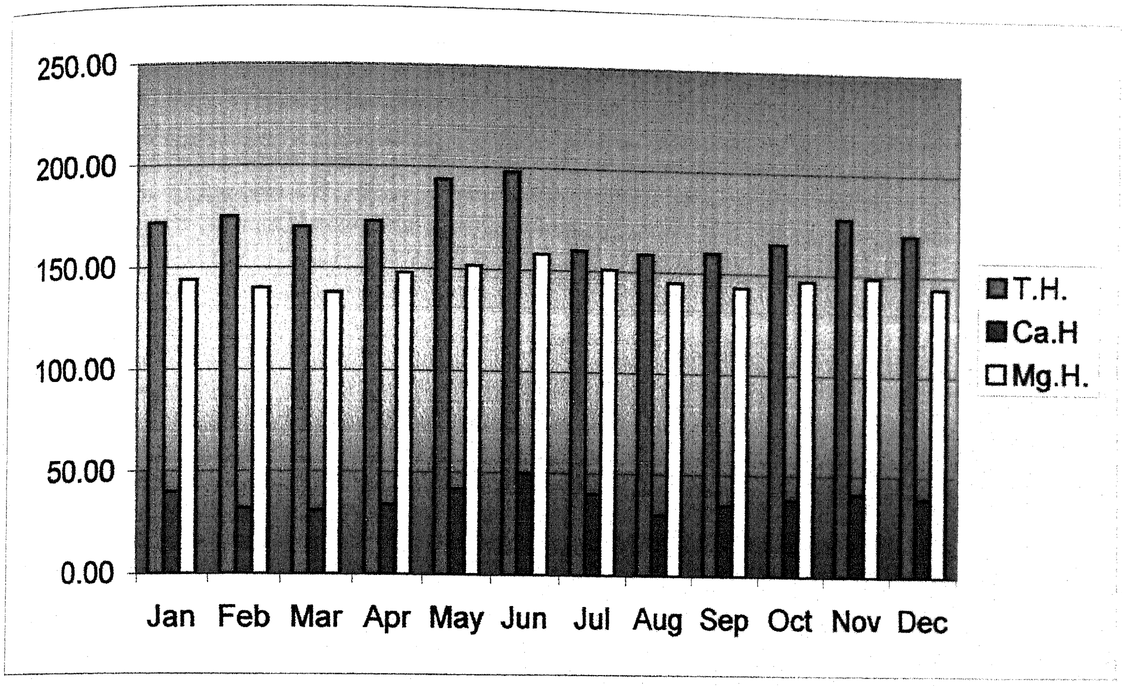


Fig-21

Station No. 2 **Year- 2005**

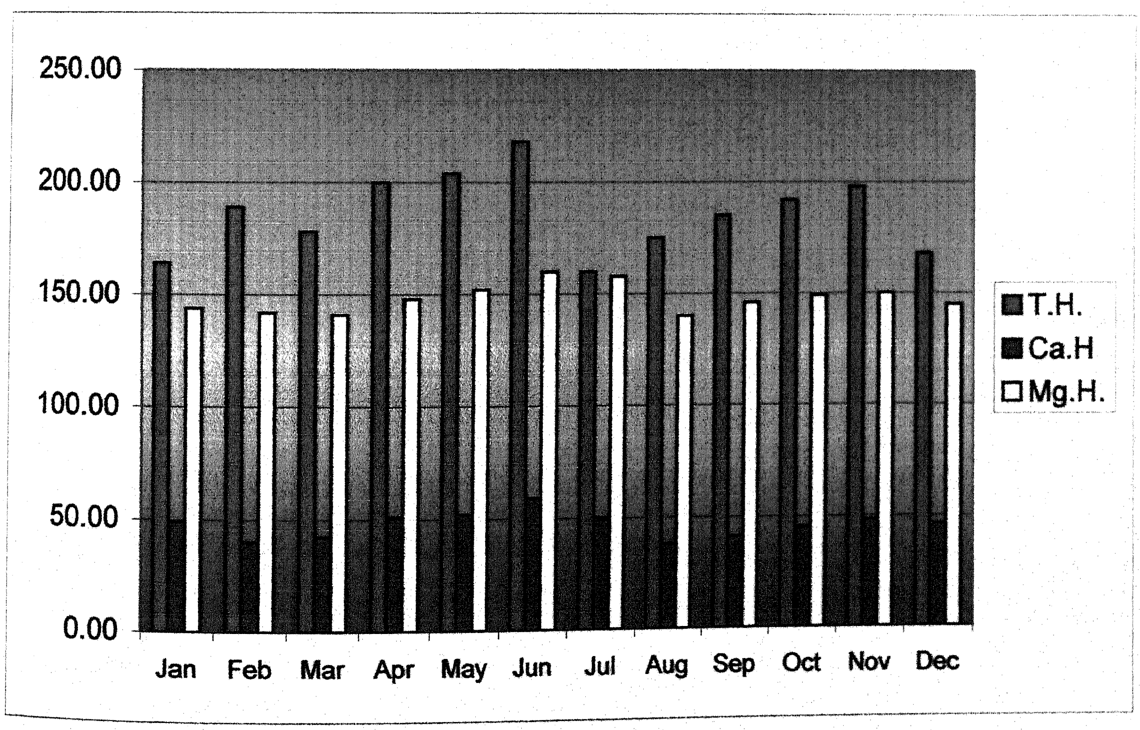


Fig-22

Total Hardness (T.H.) Calcium Hardness (Ca.H.) & Magnesium Hardness (Mg.H.)

Station No. 3

Year- 2005

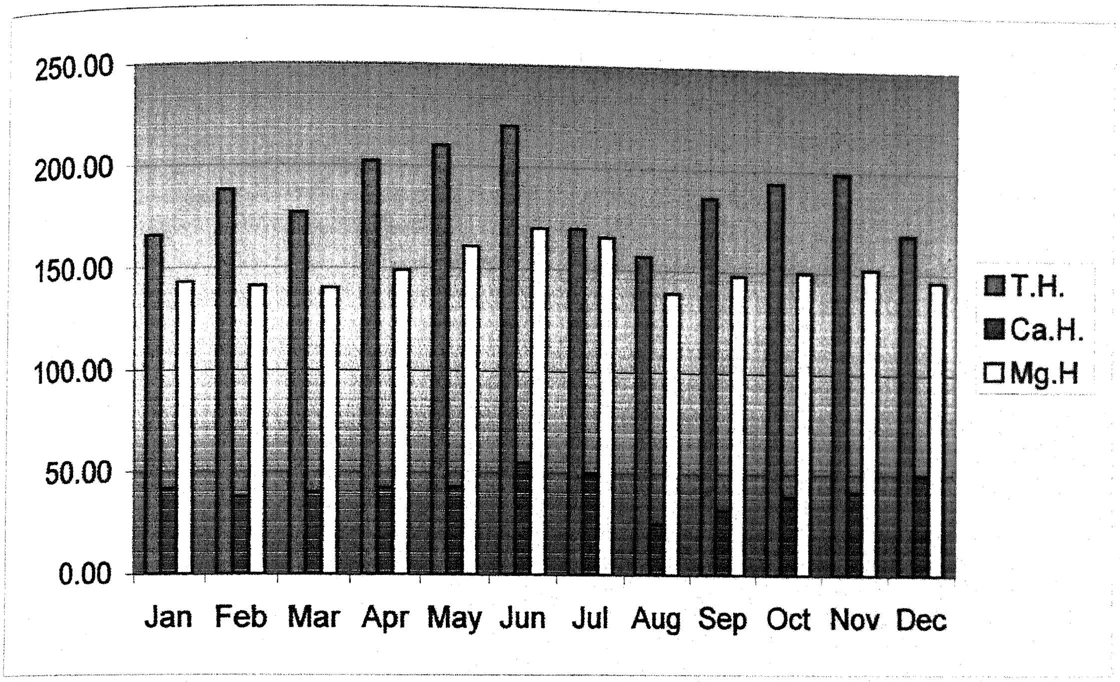


Fig-23

Station No. 4

Year- 2005

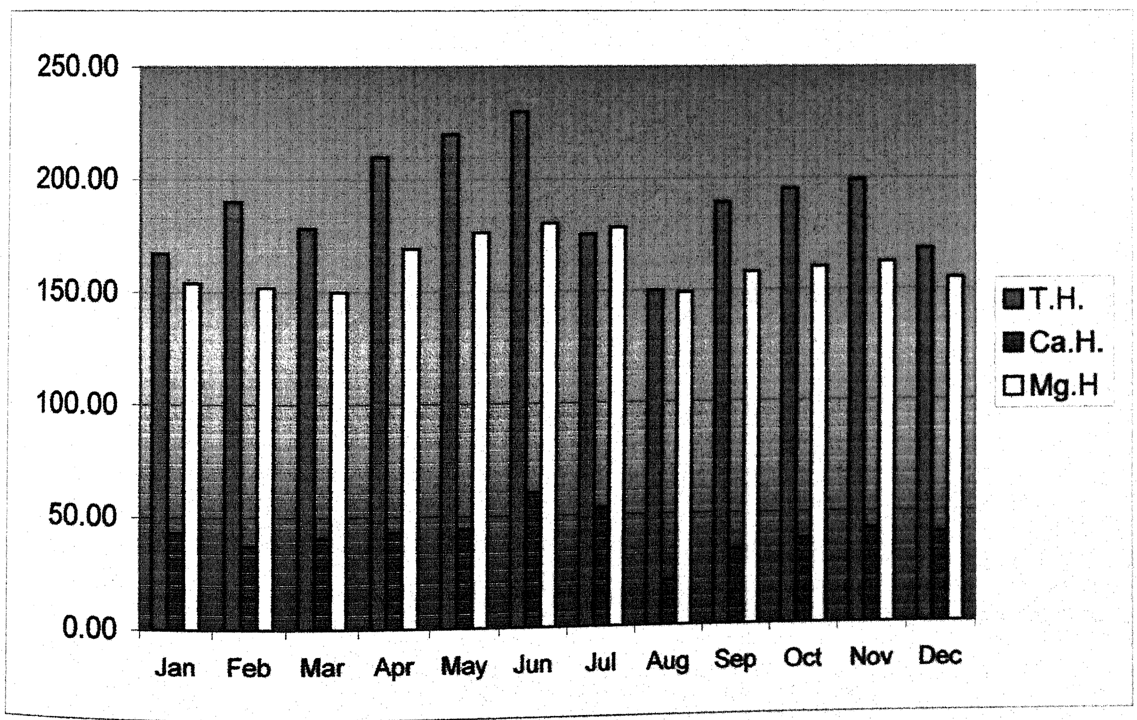


Fig-24

Total Hardness (T.H.) Calcium Hardness (Ca.H.) & Magnesium Hardness (Mg.H.)

Station No. 1

Year- 2006

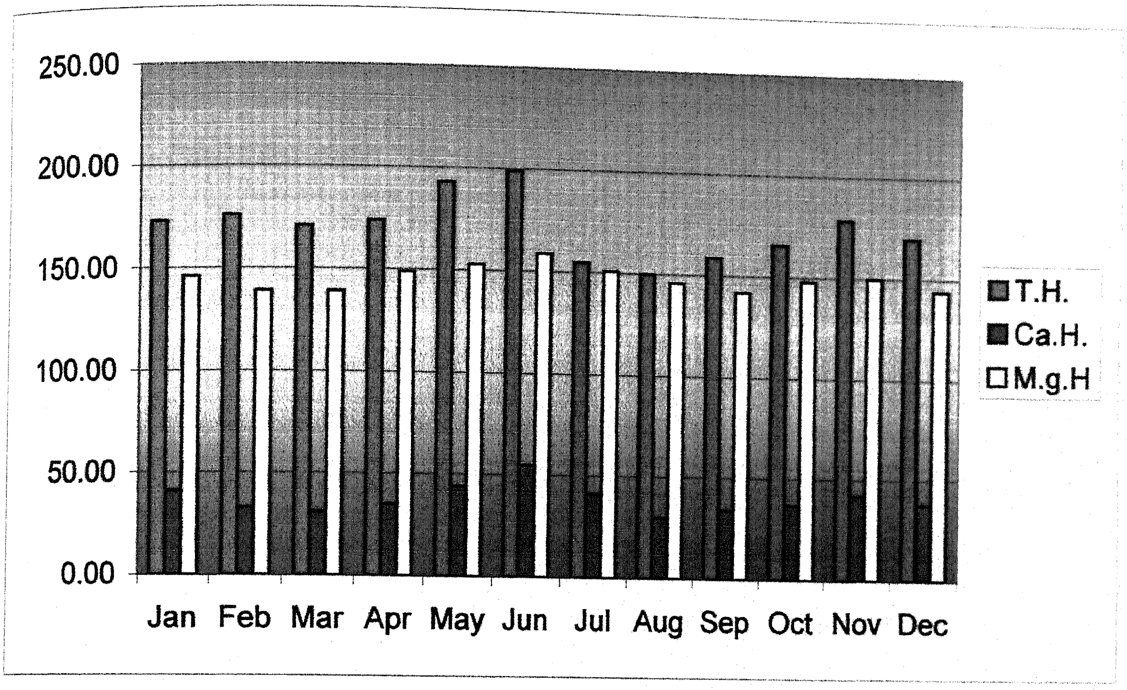


Fig-25

Station No. 2

Year- 2006

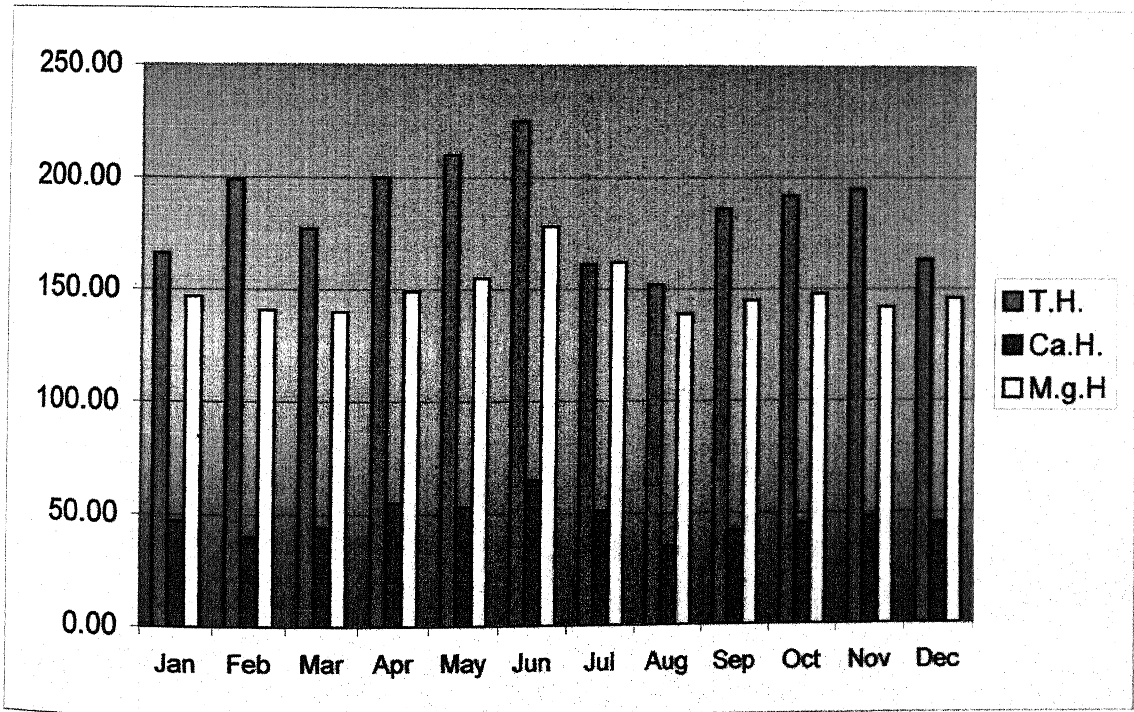


Fig-26

Total Hardness (T.H.) Calcium Hardness (Ca.H.) & Magnesium Hardness (Mg.H.)

Station No. 3

Year- 2006

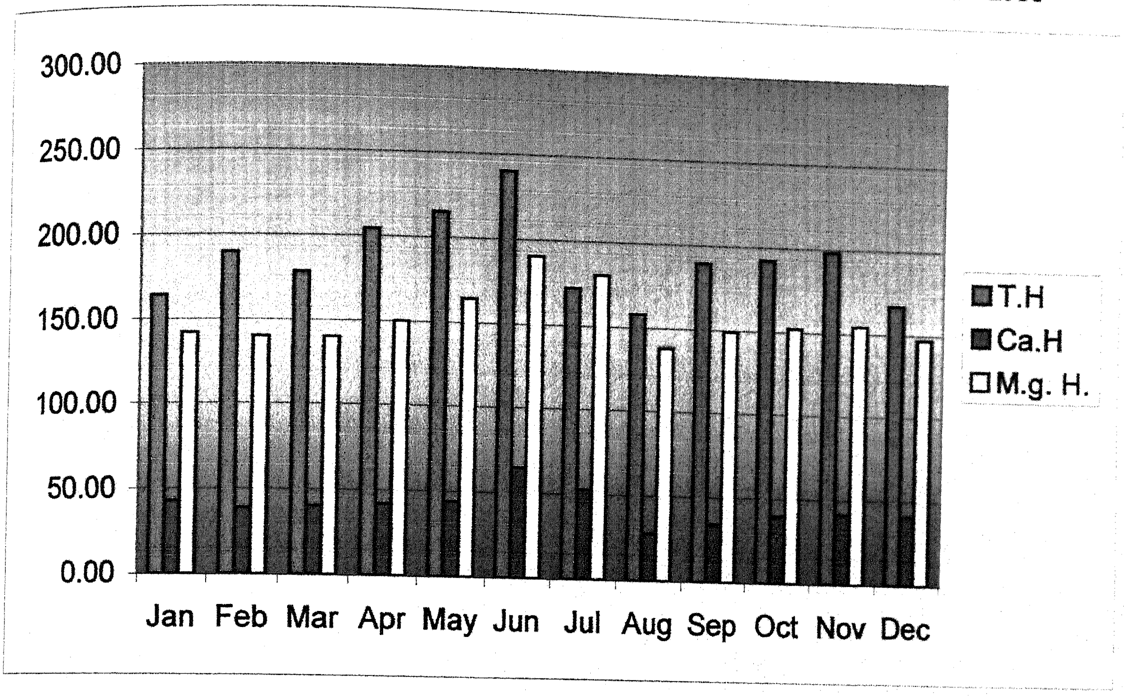


Fig-27

Station No. 4

Year- 2006

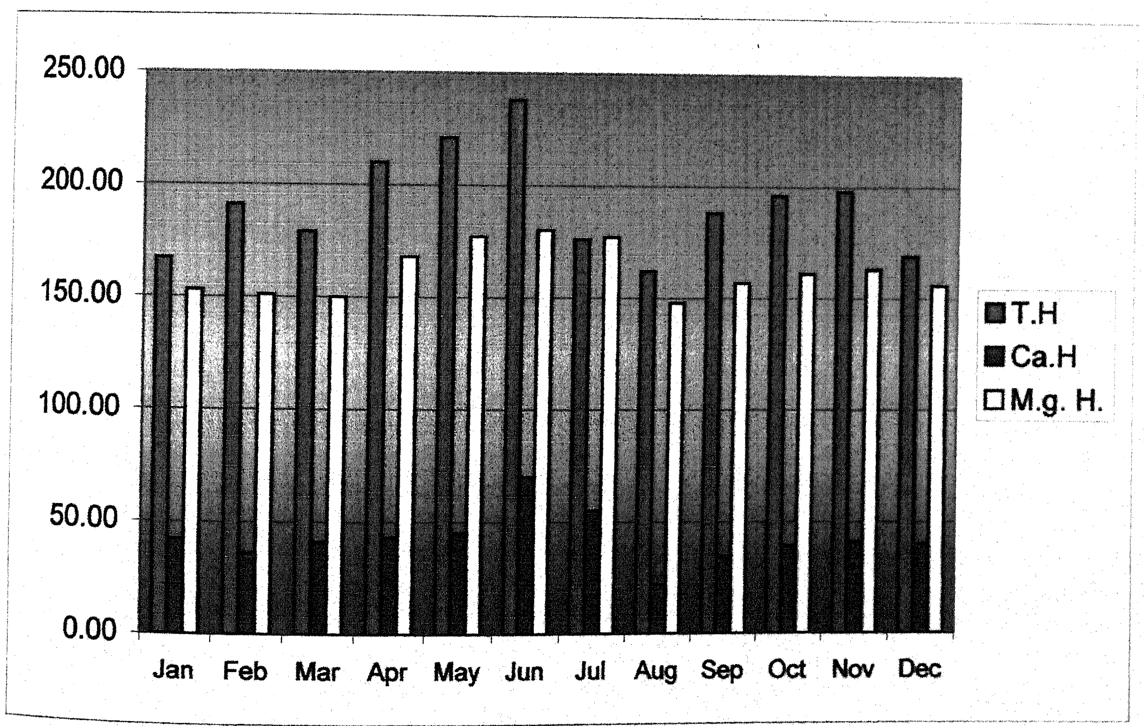


Fig-28

Dissolved Oxygen (D.O.) Biochemical Oxygen Demand (B.O.D) & Chemical Oxygen Demand (C.O.D.)

Station No. 1

Year- 2005

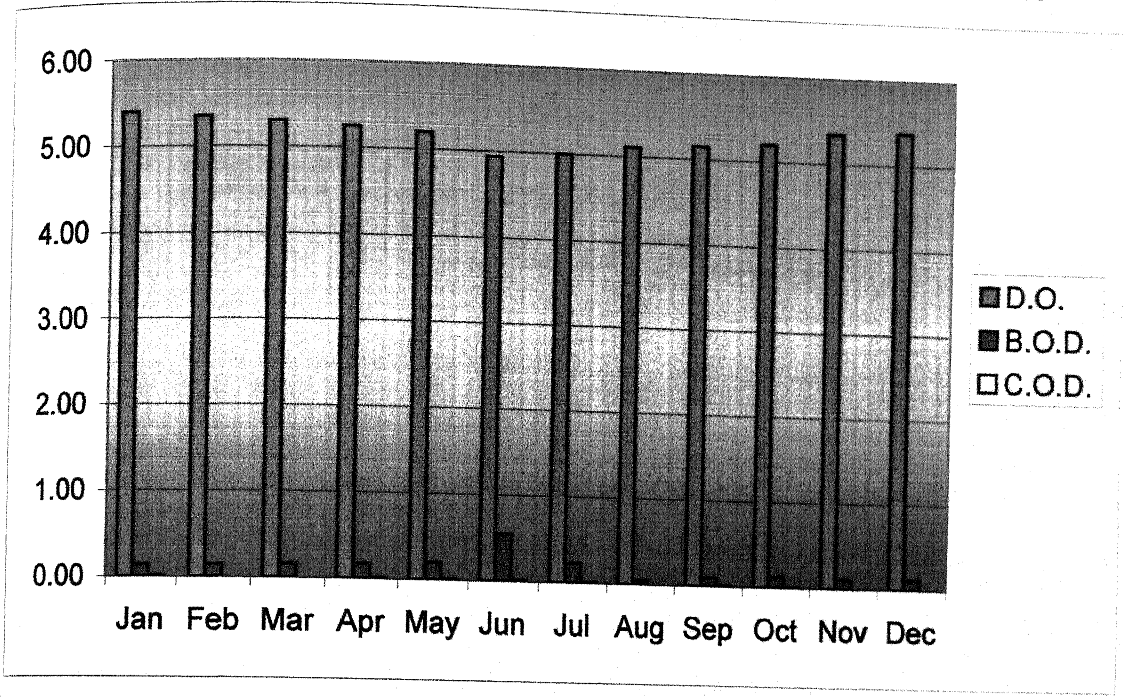


Fig-29

Station No.2

Year- 2005

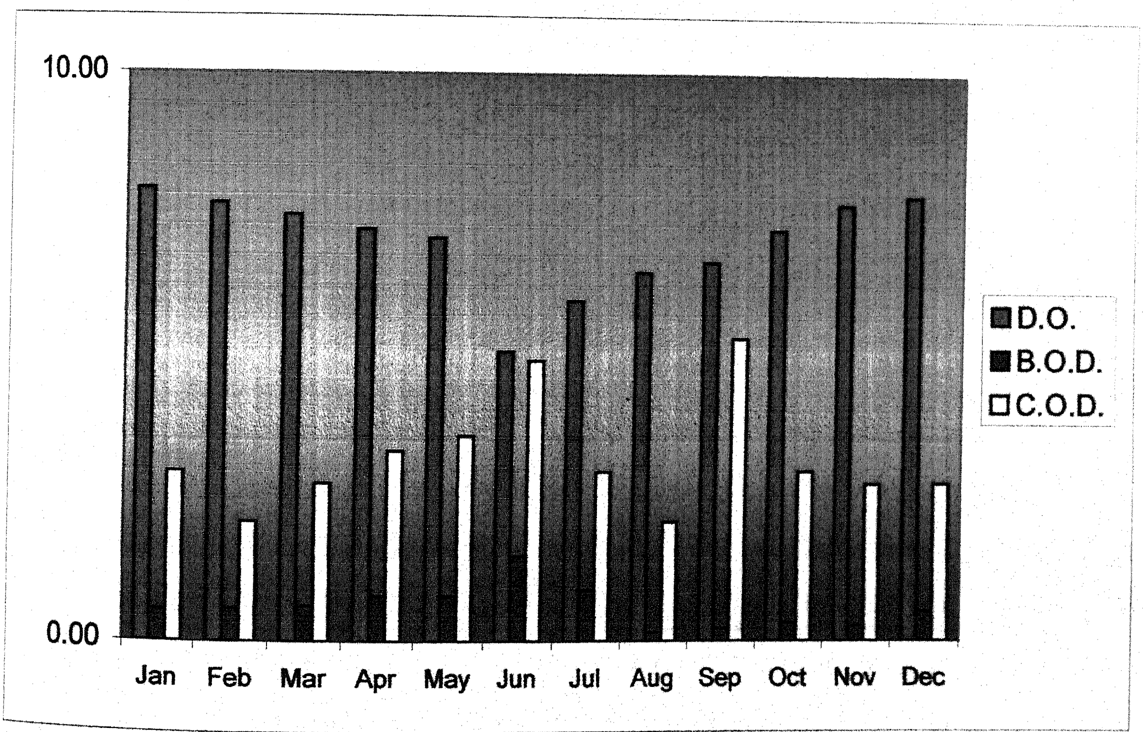


Fig-30

Dissolved Oxygen (D.O.) Biochemical Oxygen Demand (B.O.D) & Chemical Oxygen Demand (C.O.D.)

Station No. 3

Year- 2005

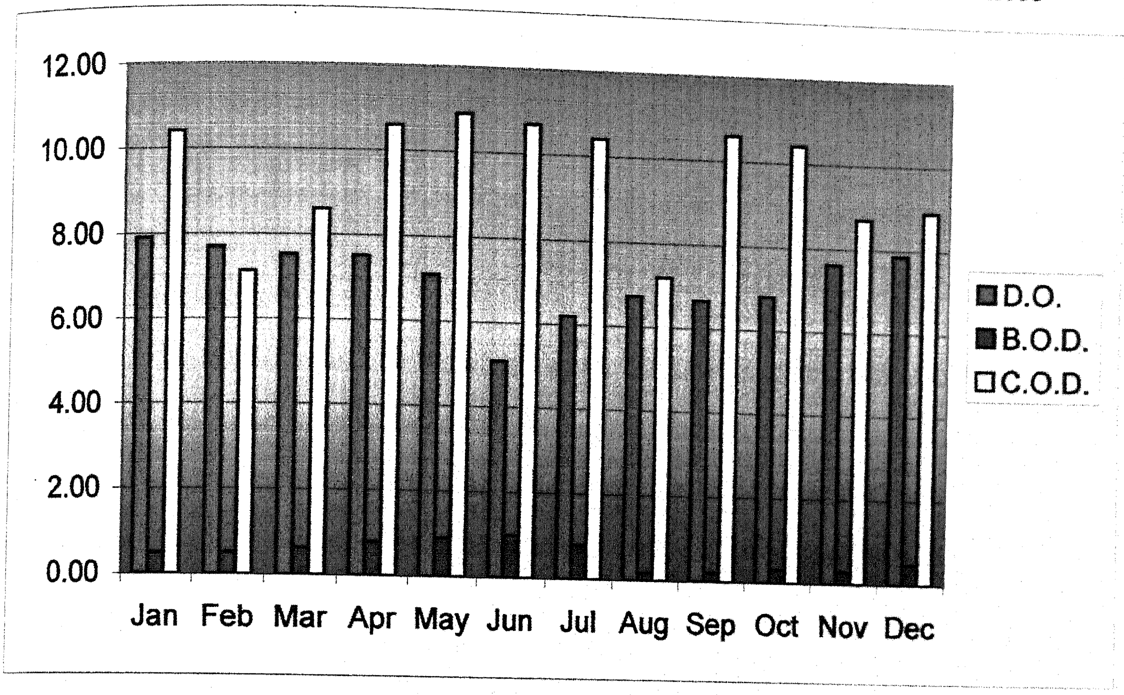


Fig-31

Station No. 4

Year- 2005

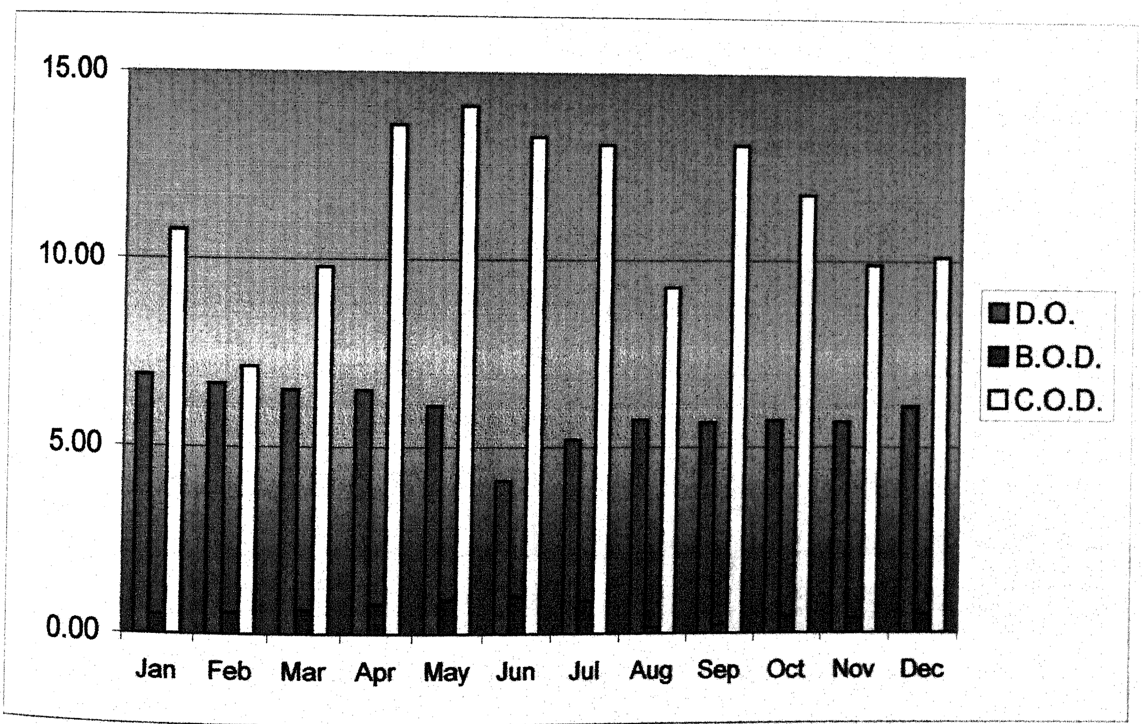


Fig-32

Dissolved Oxygen (D.O.) Biochemical Oxygen Demand (B.O.D) & Chemical Oxygen Demand (C.O.D.)

Station No. 1

Year- 2006

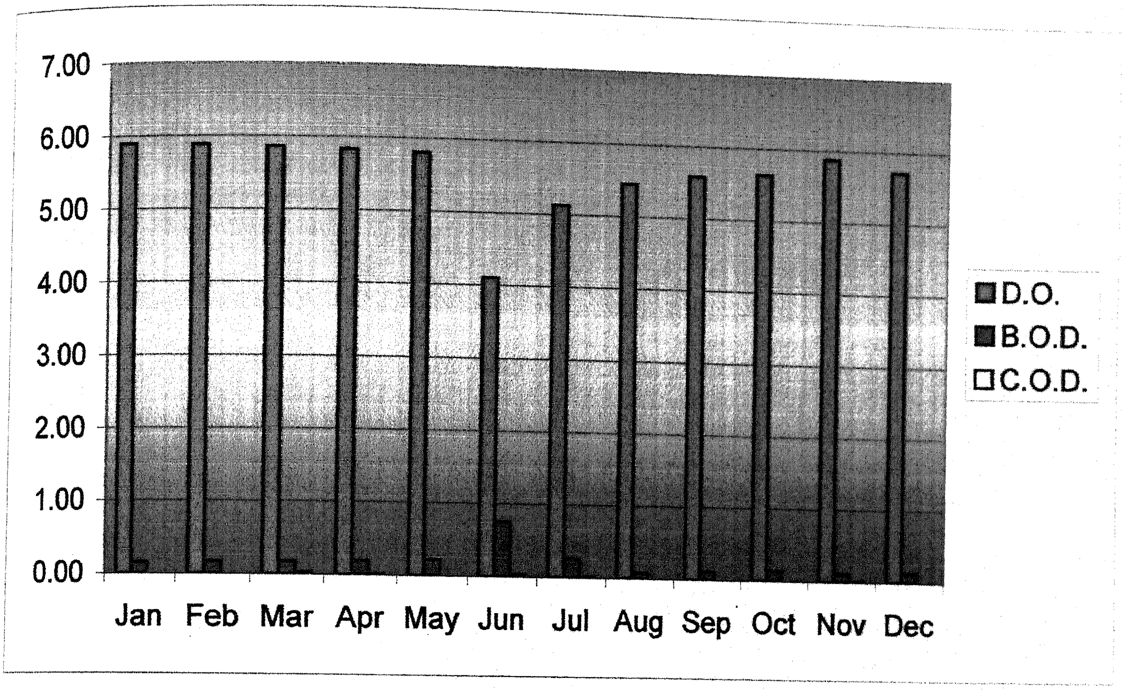


Fig-33

Station No. 2

Year- 2006

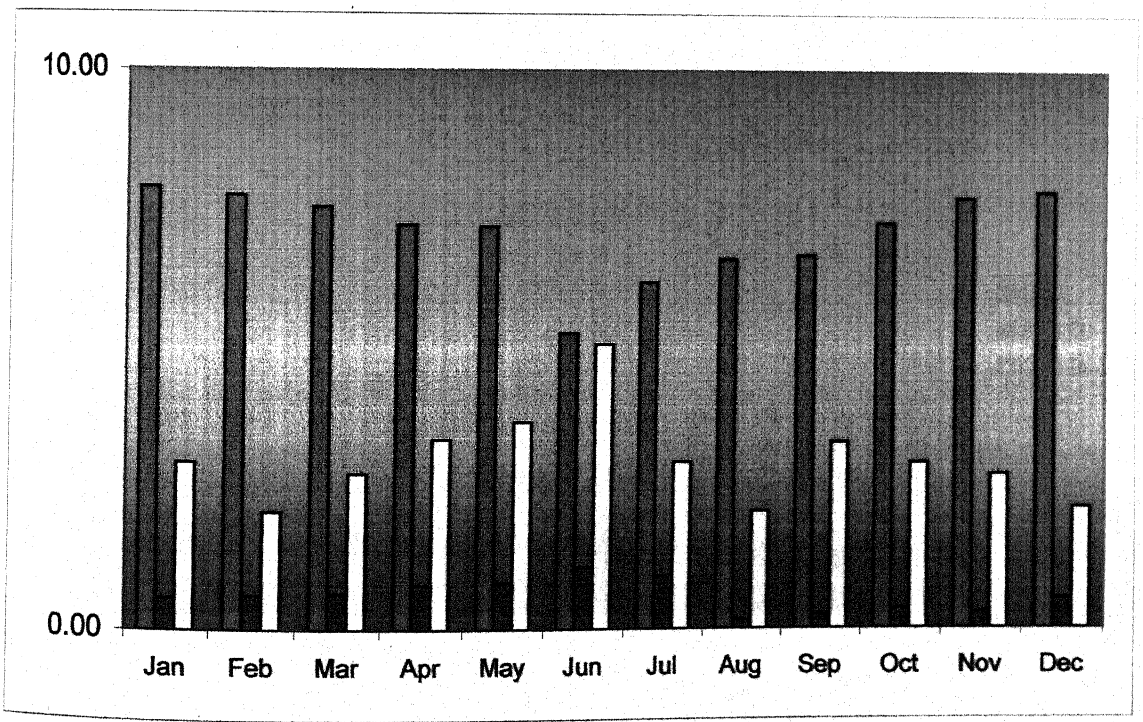


Fig-34

Dissolved Oxygen (D.O.) Biochemical Oxygen Demand (B.O.D) & Chemical Oxygen Demand (C.O.D.)

Station No. 3

Year- 2006

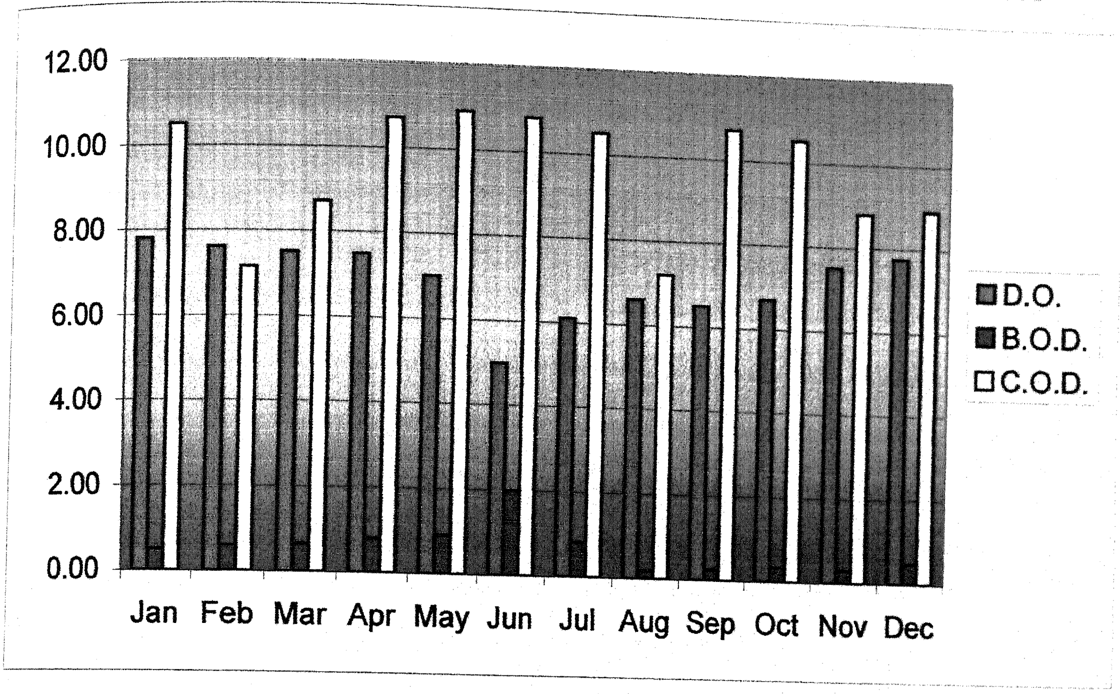


Fig-35

Station No. 4

Year- 2006

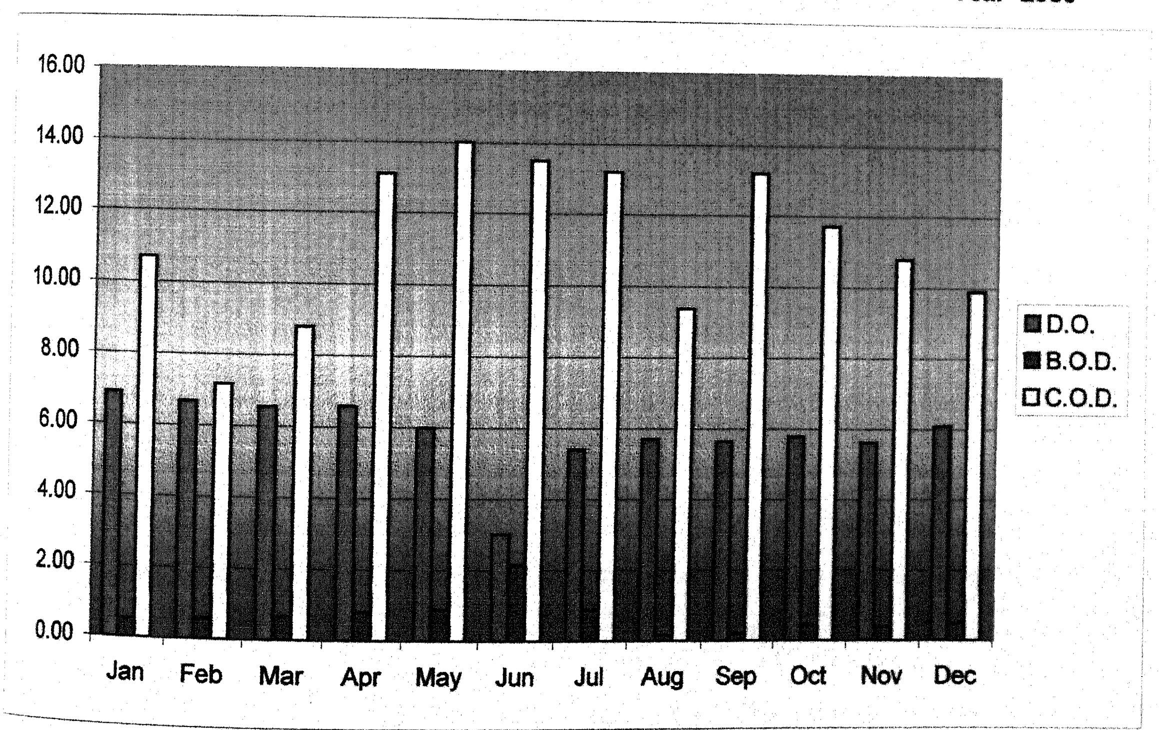


Fig-36

Ammonical Nitrogen (NH_4-N), Nitrite Nitrogen (NO_2-N) & Nitrate Nitrogen (NO_3-N)

Station No.1

Year- 2005

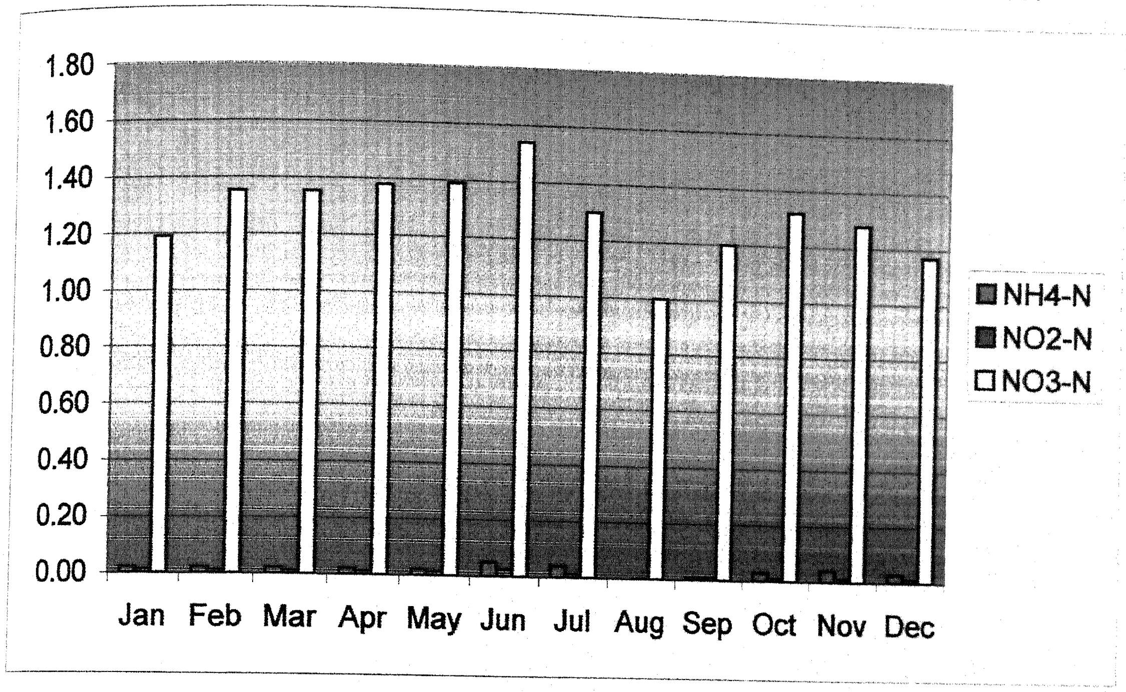


Fig-37

Station No.2

Year- 2005

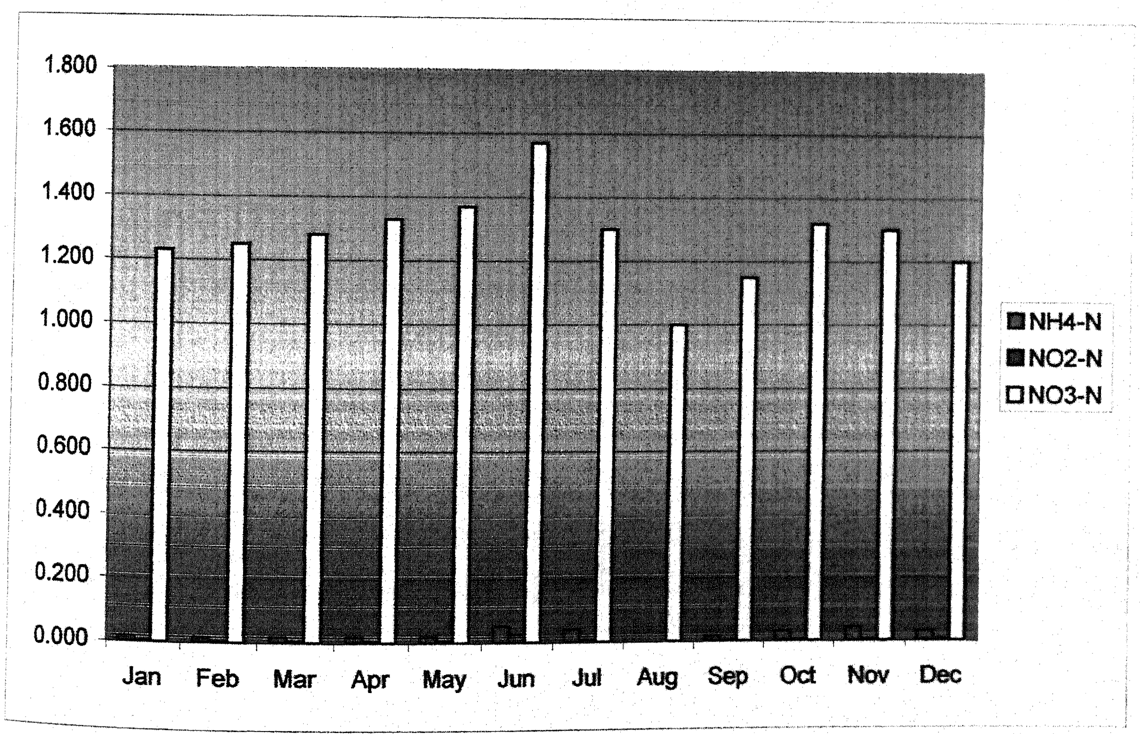


Fig-38

Ammonical Nitrogen (NH_4-N), Nitrite Nitrogen (NO_2-N) & Nitrate Nitrogen (NO_3-N)

Station No.3

Year- 2005

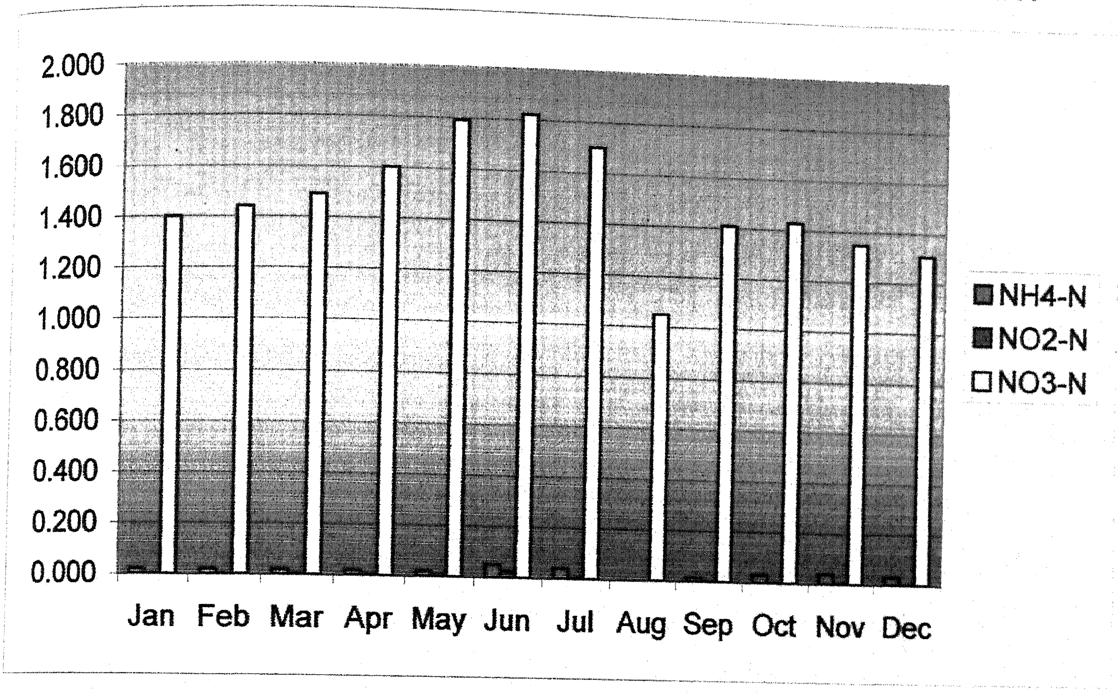


Fig-39

Station No.4

Year- 2005

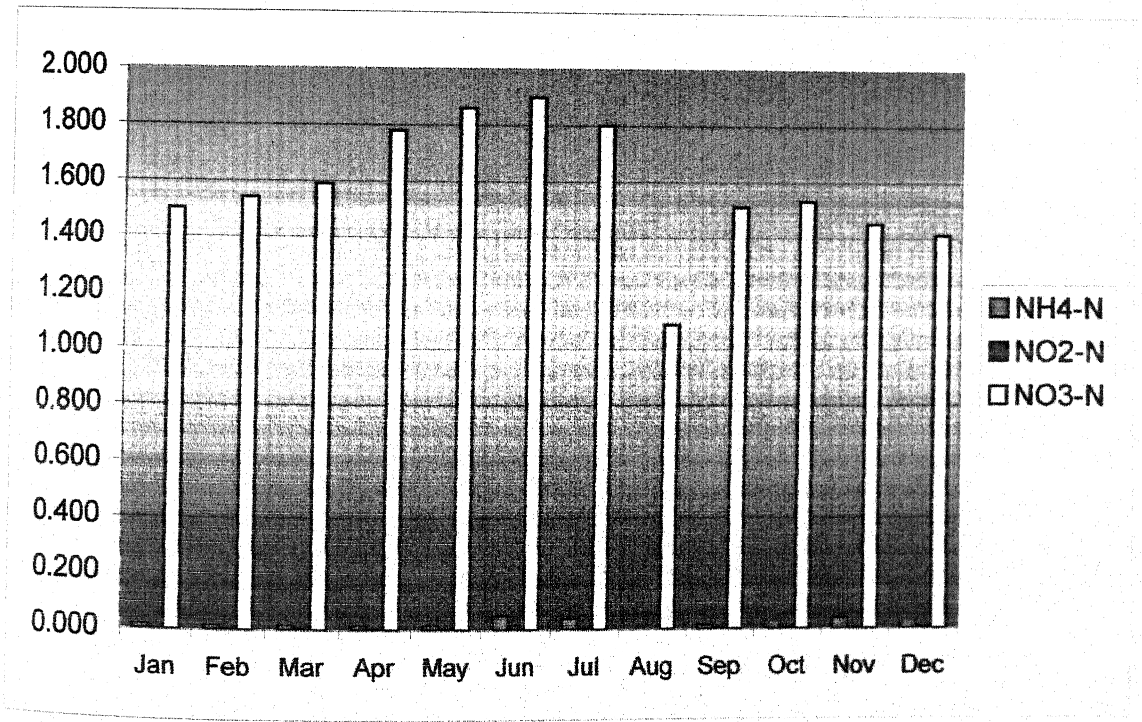


Fig-40

Ammonical Nitrogen (NH_4-N), Nitrite Nitrogen (NO_2-N) & Nitrate Nitrogen (NO_3-N)

Station No. 1

Year- 2006

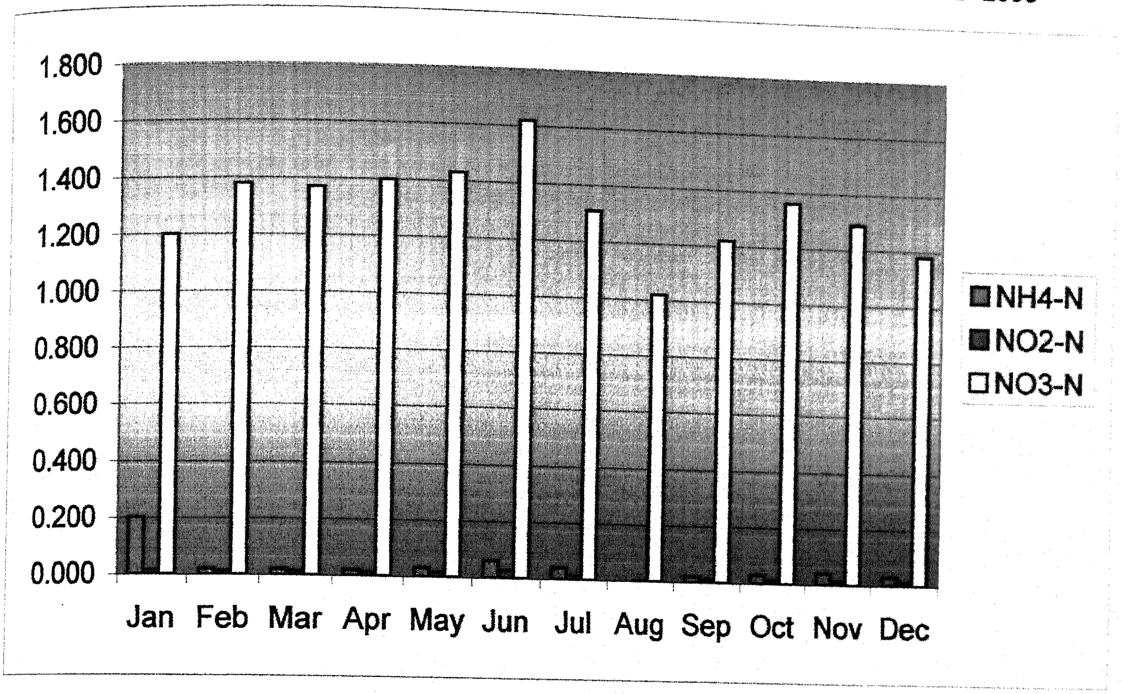


Fig-41

Station No. 2

Year- 2006

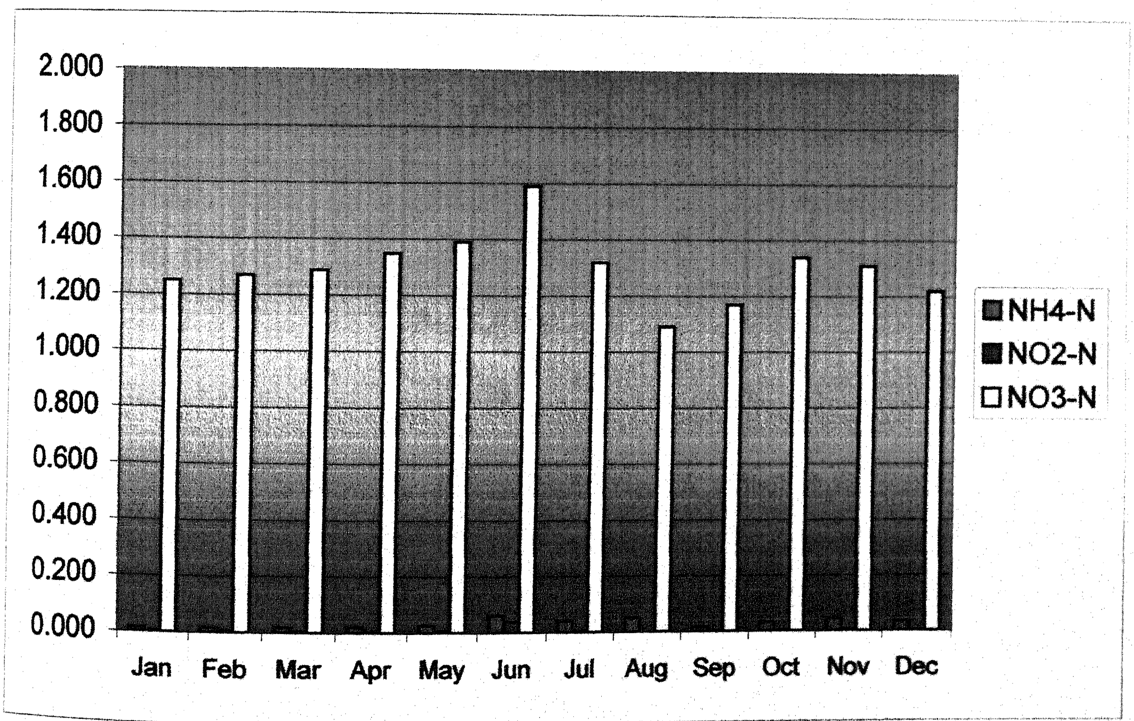


Fig-42

Ammonical Nitrogen (NH_4-N), Nitrite Nitrogen (NO_2-N) & Nitrate Nitrogen (NO_3-N)

Station No. 3

Year- 2006

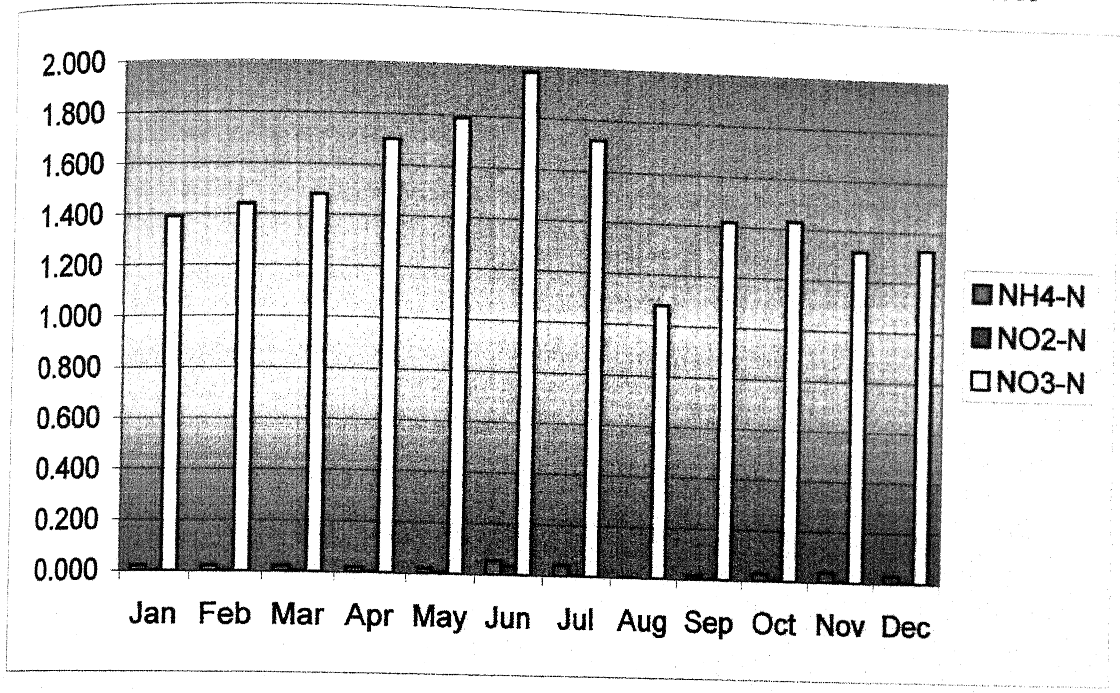


Fig-43

Station No. 4

Year- 2006

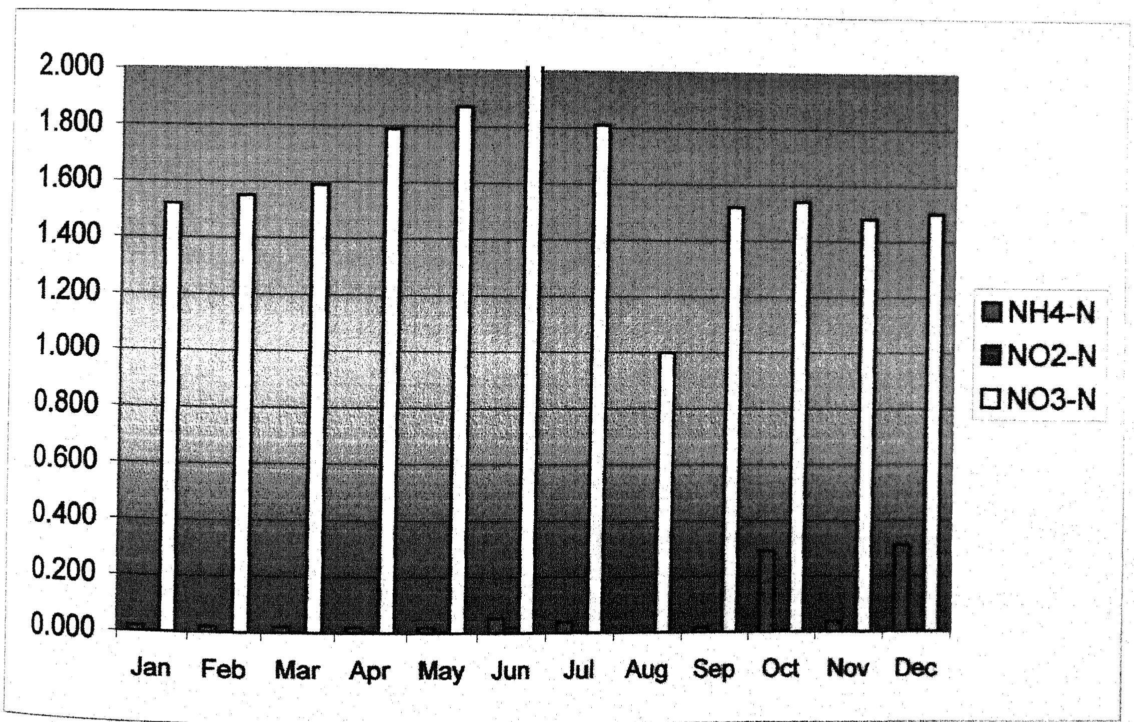


Fig-44

Ammonical Nitrogen (NH_4-N), Phosphate (PO_4) & Suplhate (SO_4)

Station No. 1

Year- 2005

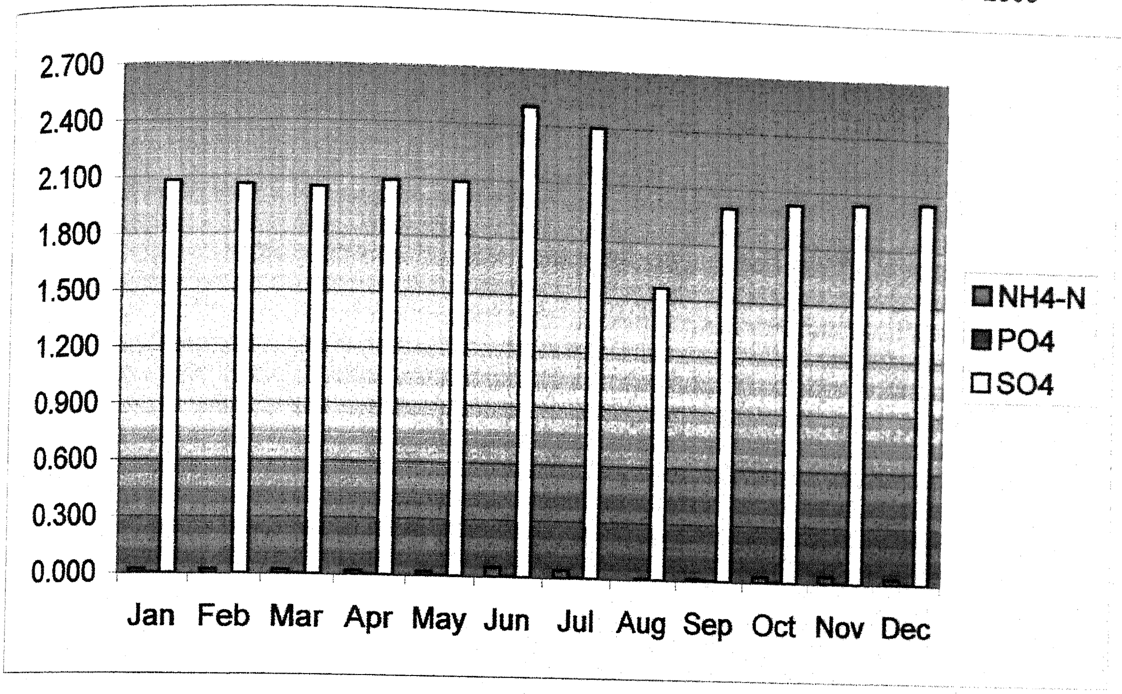


Fig-45

Station No.2

Year- 2005

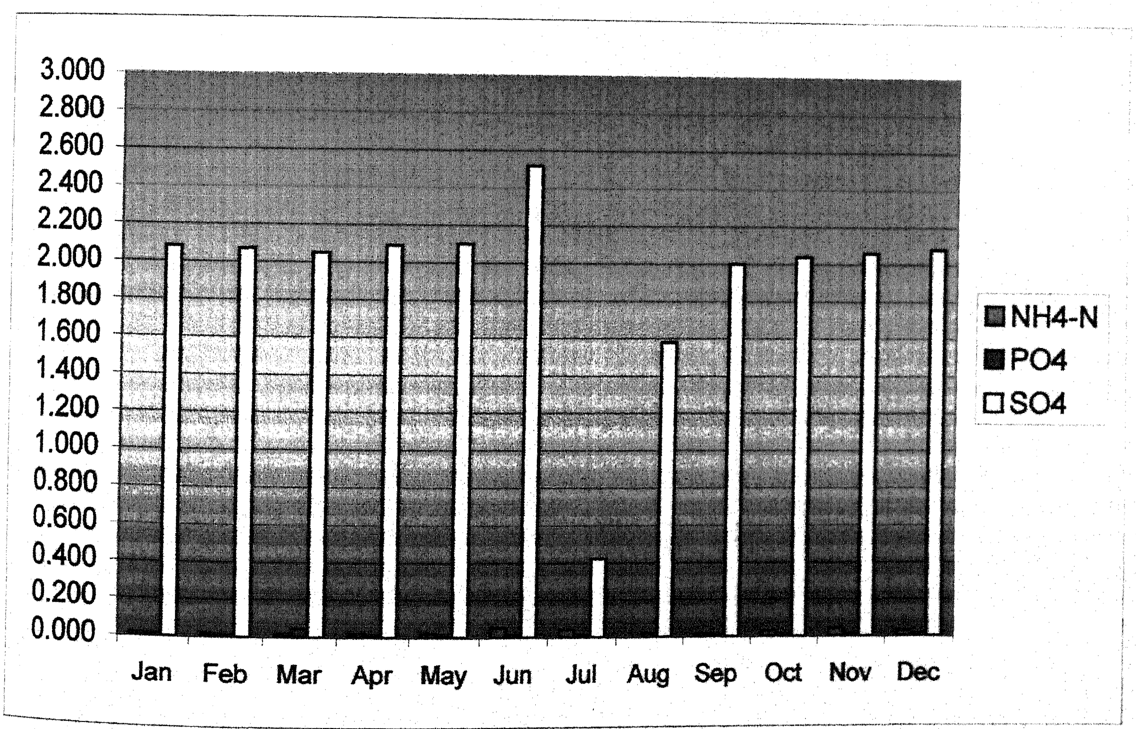


Fig-46

Ammonical Nitrogen (NH_4-N), Phosphate (PO_4) & Suplhate (SO_4)

Station No. 3

Year- 2005

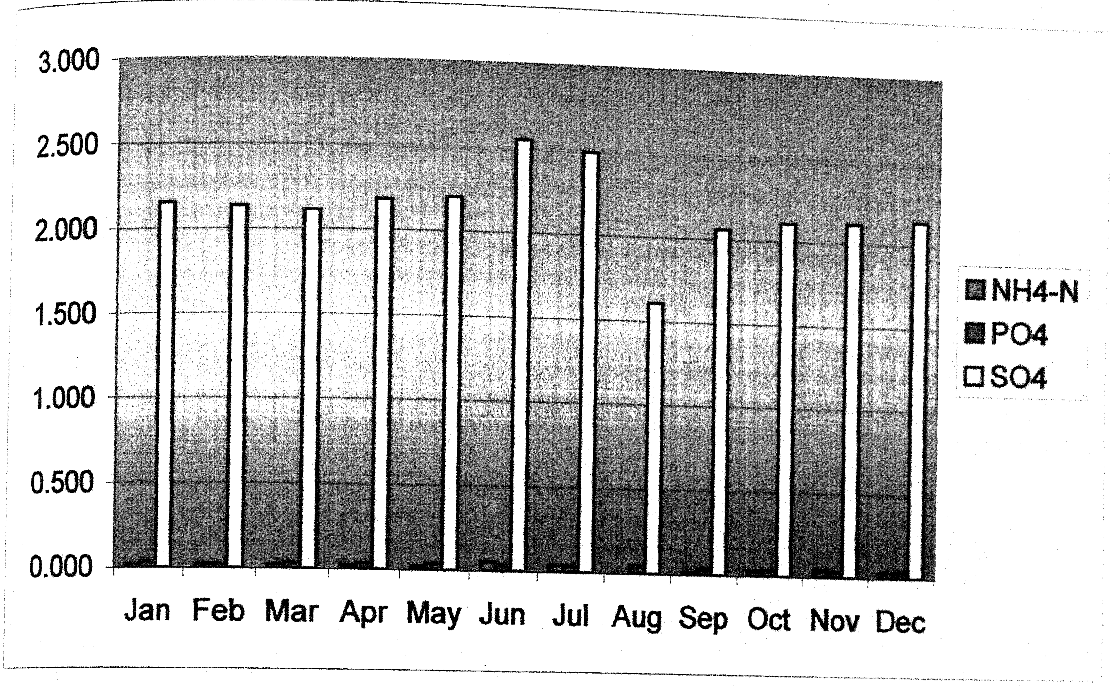


Fig-47

Station No. 3

Year- 2005

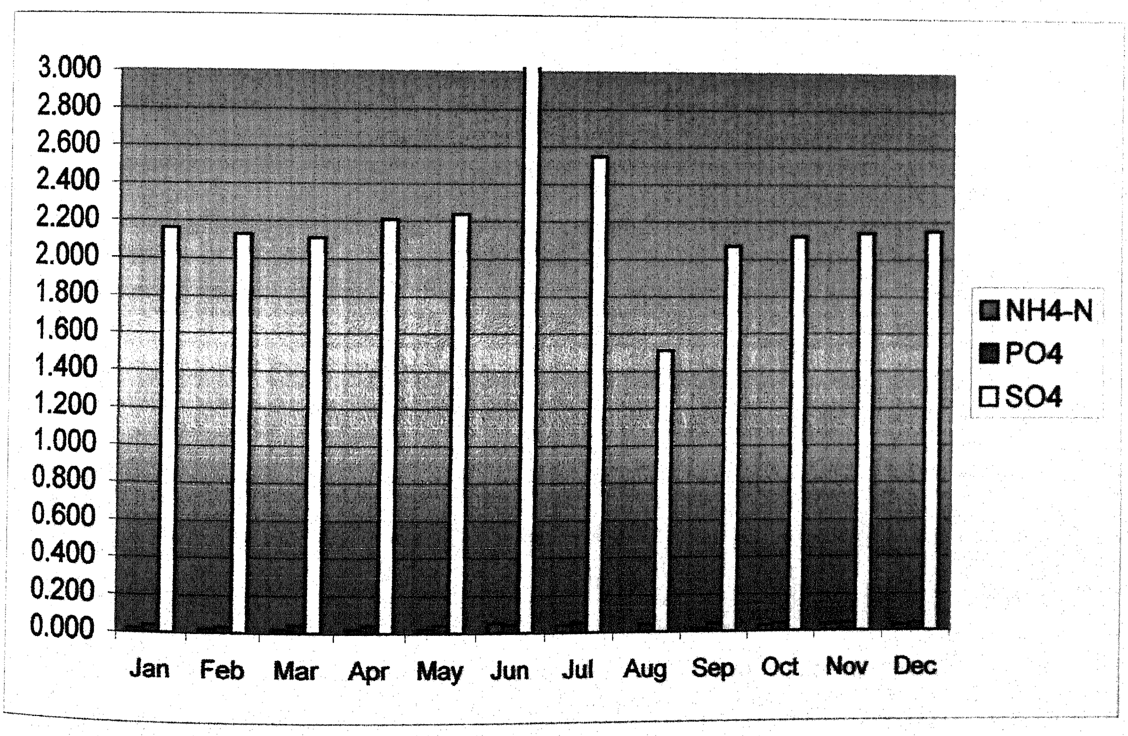


Fig-48

Ammonical Nitrogen (NH_4-N), Phosphate (PO_4) & Suplhate (SO_4)

Station No. 1

Year- 2006

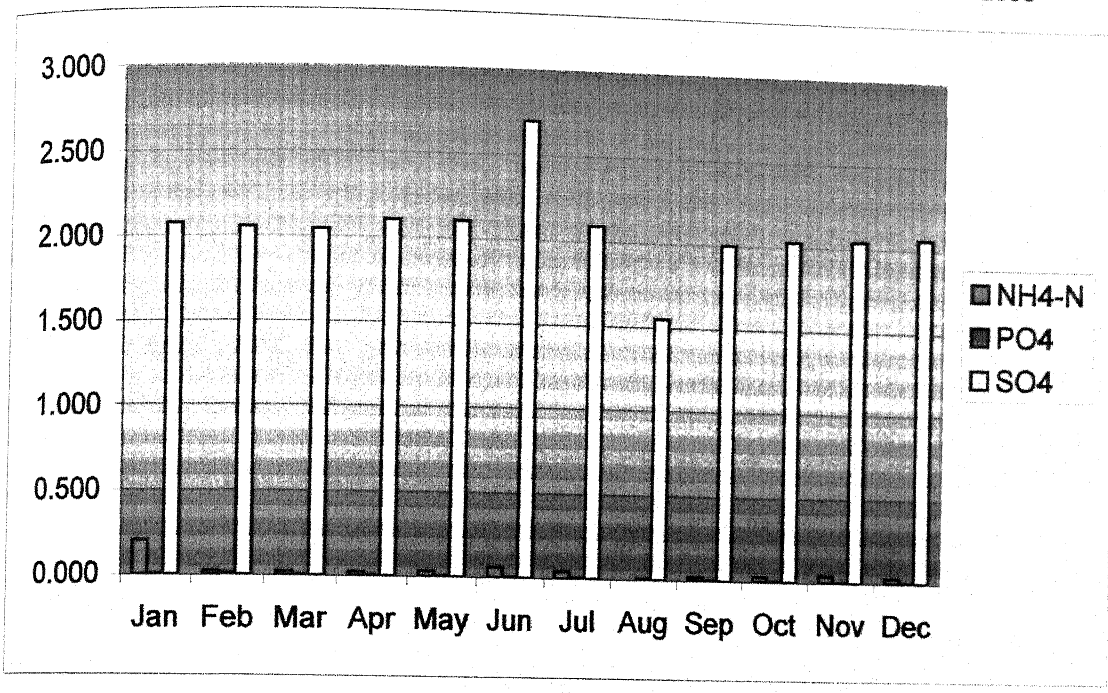


Fig-49

Station No. 2

Year- 2006

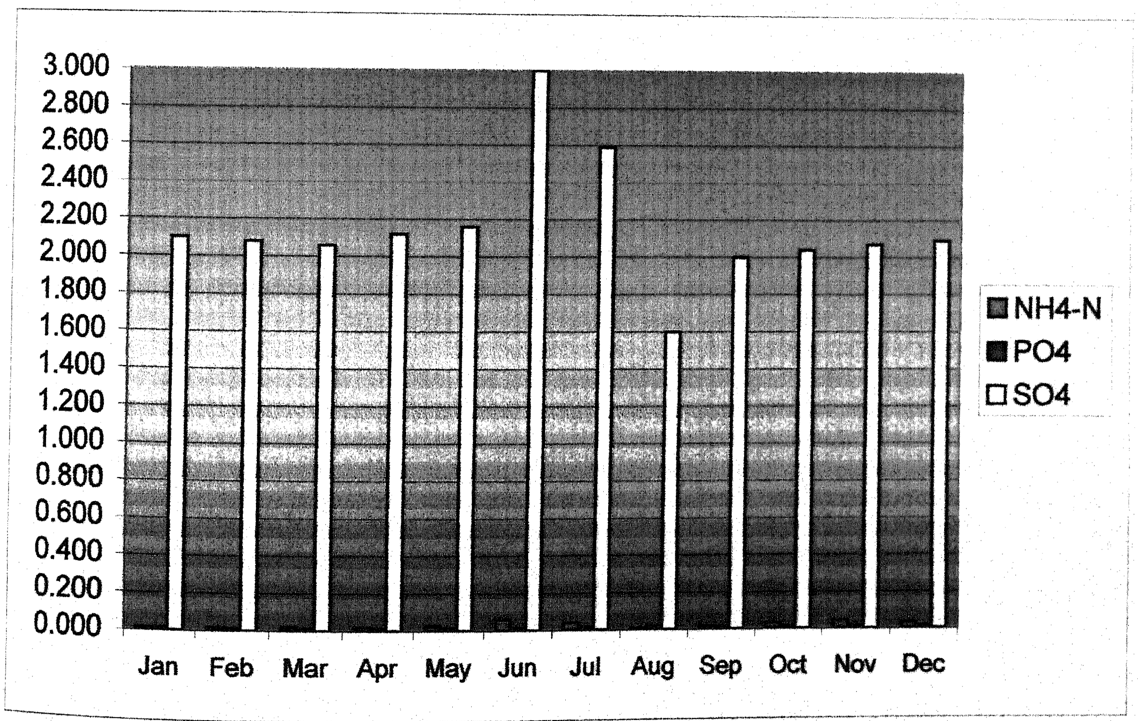


Fig-50

Ammonical Nitrogen (NH_4-N), Phosphate (PO_4) & Suplhate (SO_4)

Station No. 3

Year- 2006

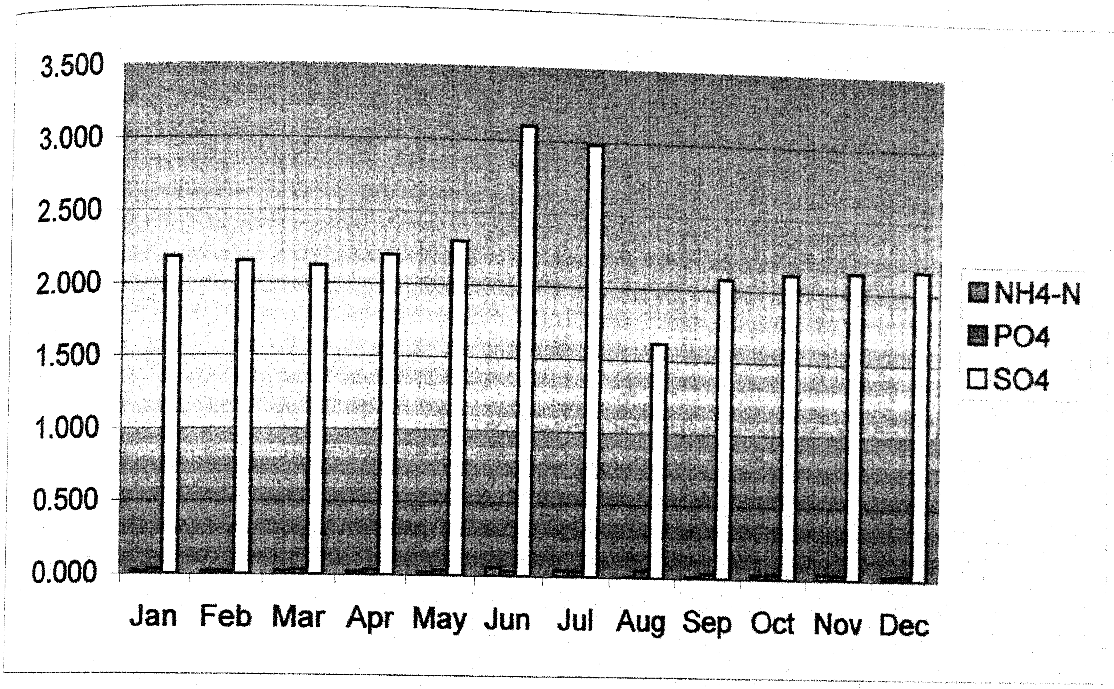


Fig-51

Station No. 4

Year- 2006

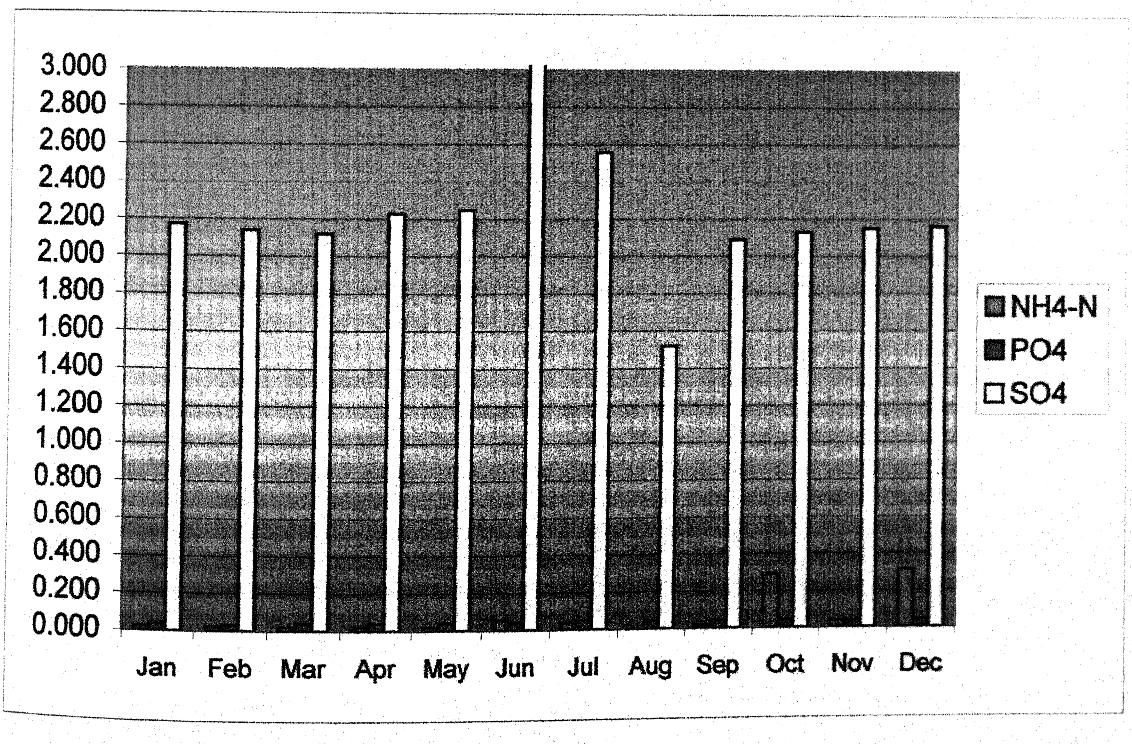


Fig-52

Sodium (Na), Potassium (K) & Fluoride

Station No. 1

Year- 2005

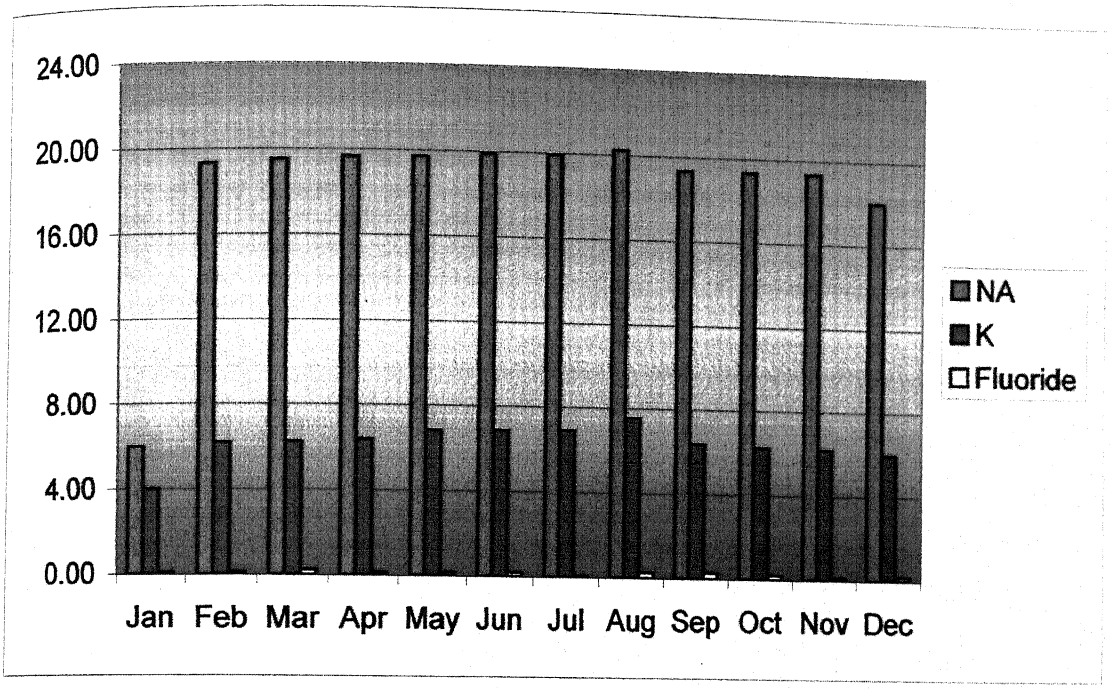


Fig-53

Station No. 2

Year- 2005

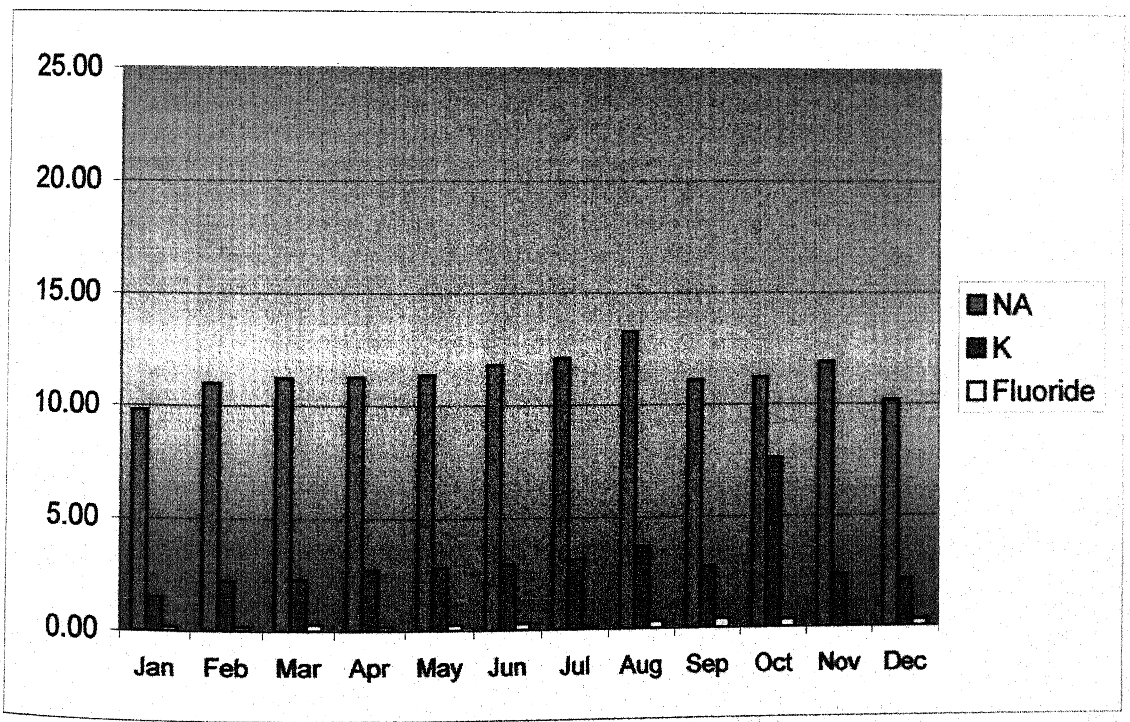


Fig-54

Sodium (Na), Potassium (K) & Fluoride

Station No. 3

Year- 2005

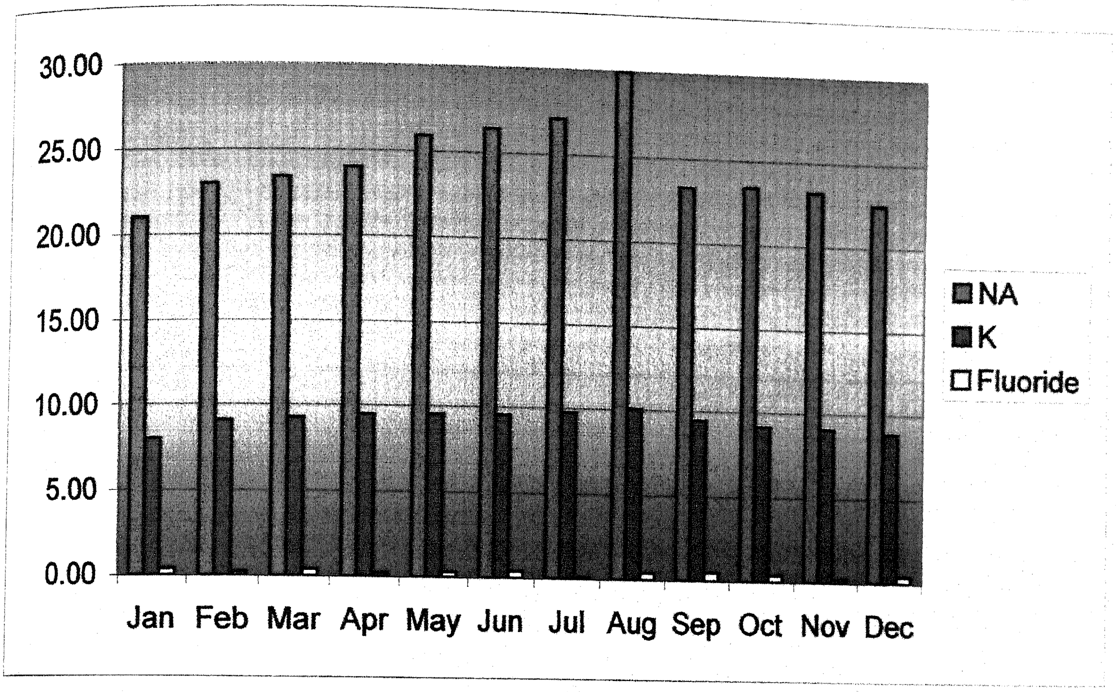


Fig-55

Station No. 4

Year- 2005

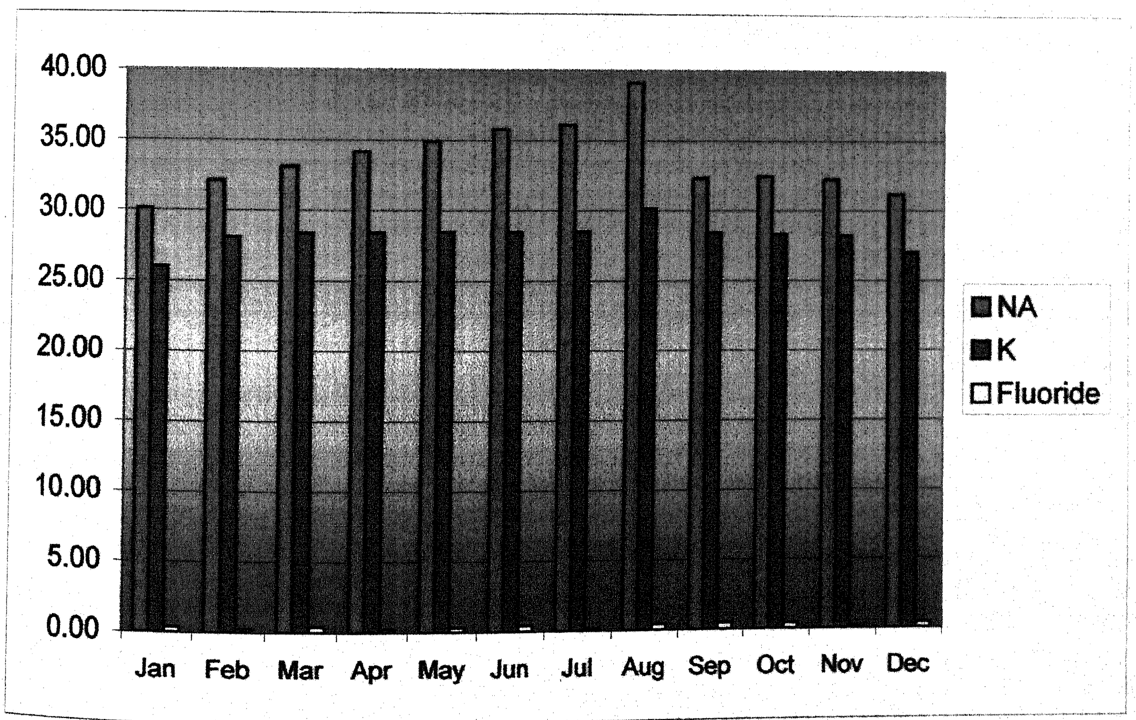


Fig-56

Sodium (Na), Potassium (K) & Fluoride

Station No. 1

Year- 2006

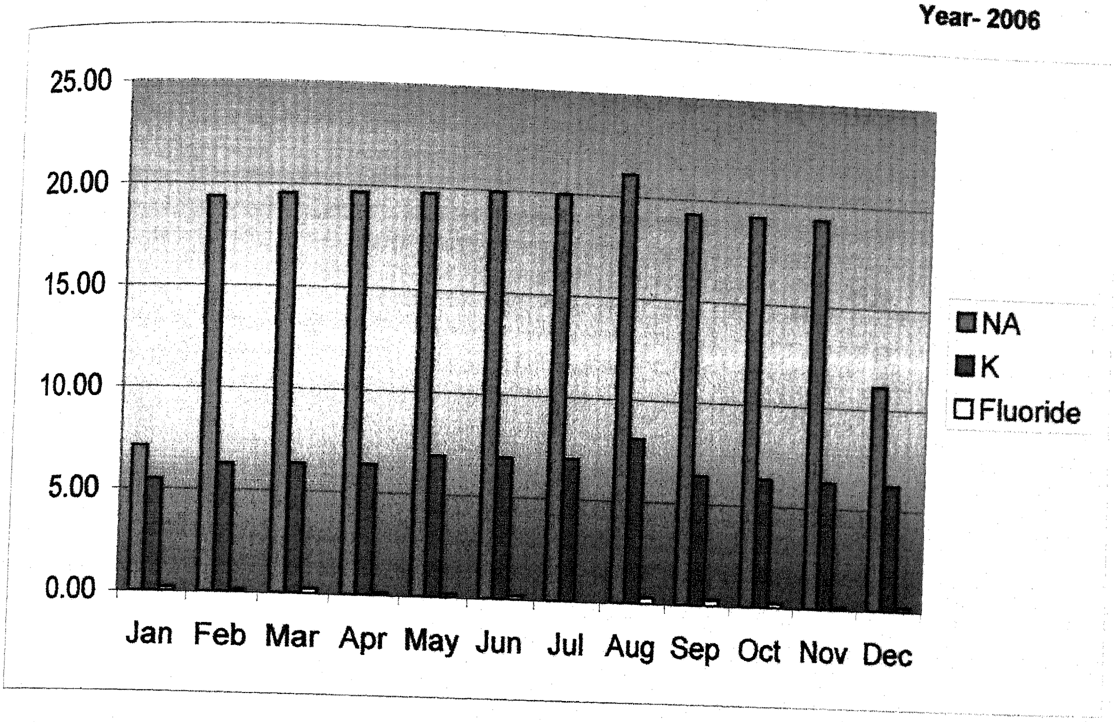


Fig-57

Station No. 2

Year- 2006

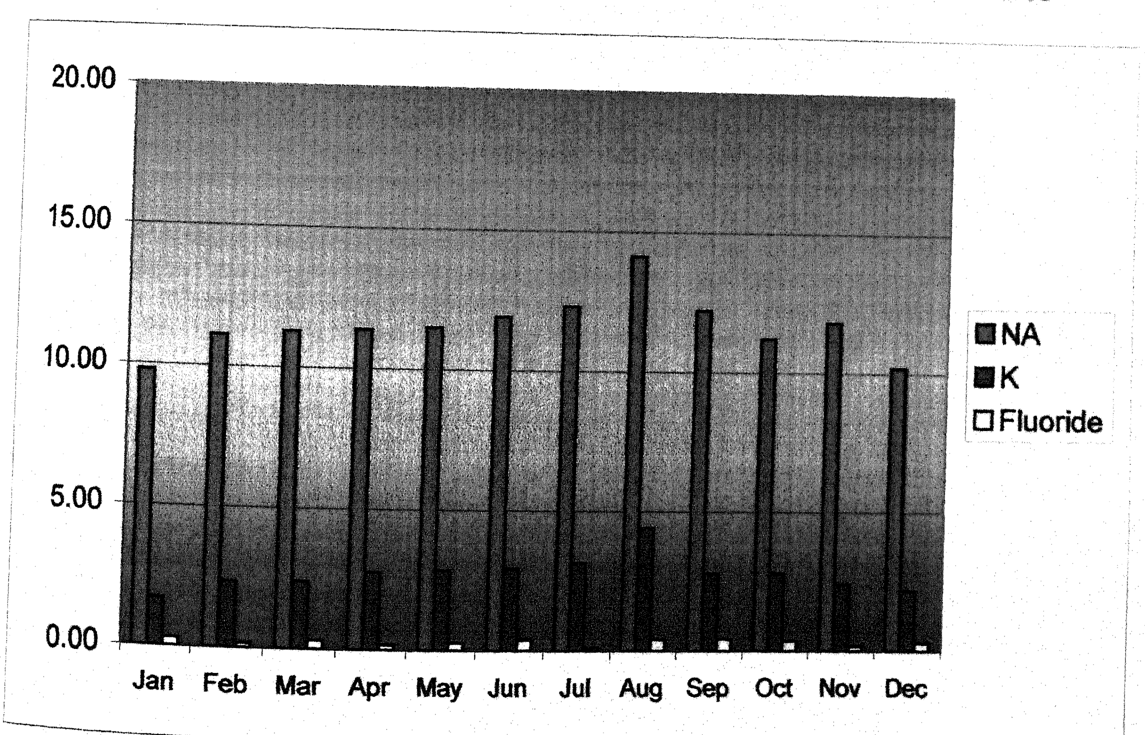


Fig-58

Sodium (Na), Potassium (K) & Fluoride

Station No. 3

Year- 2006

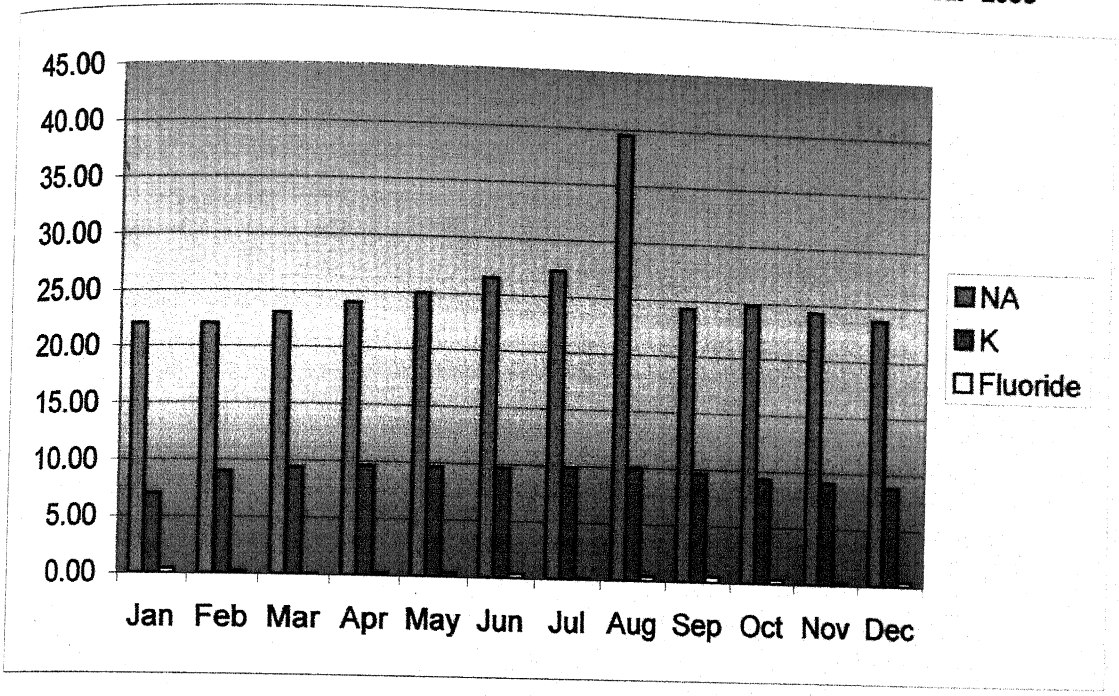


Fig-59

Station No. 4

Year- 2006

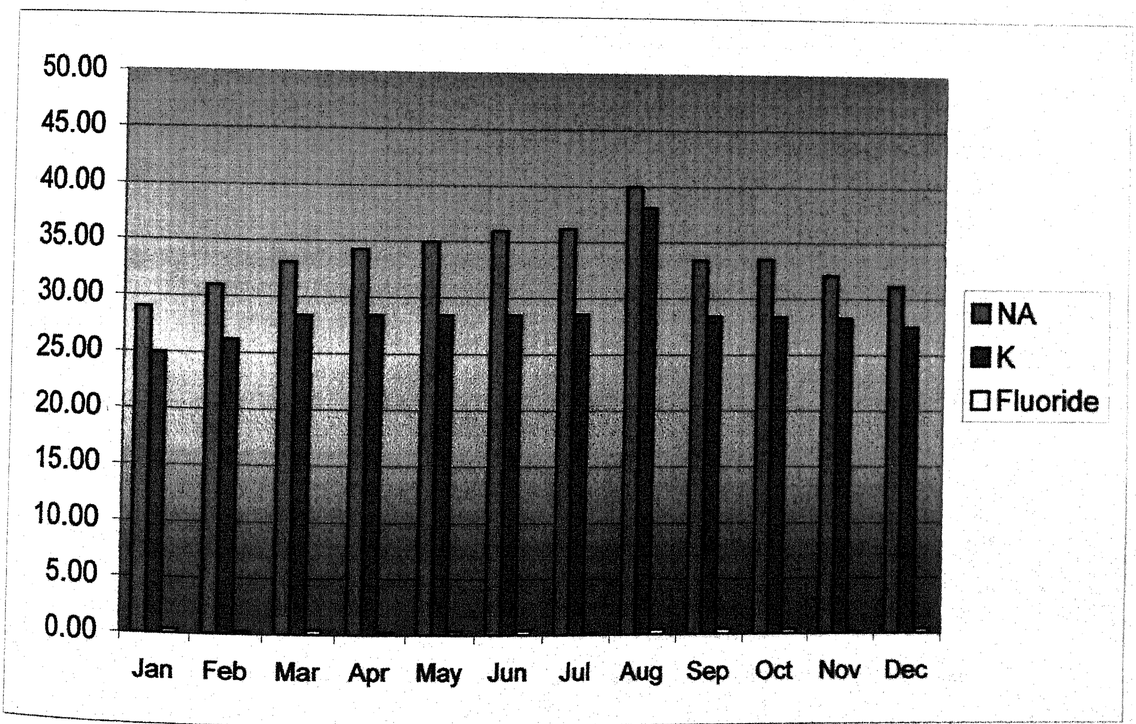


Fig-60

Water Current, Carbon-di-Oxide (CO_2) & M.P.N.

Station No. 1

Year- 2005

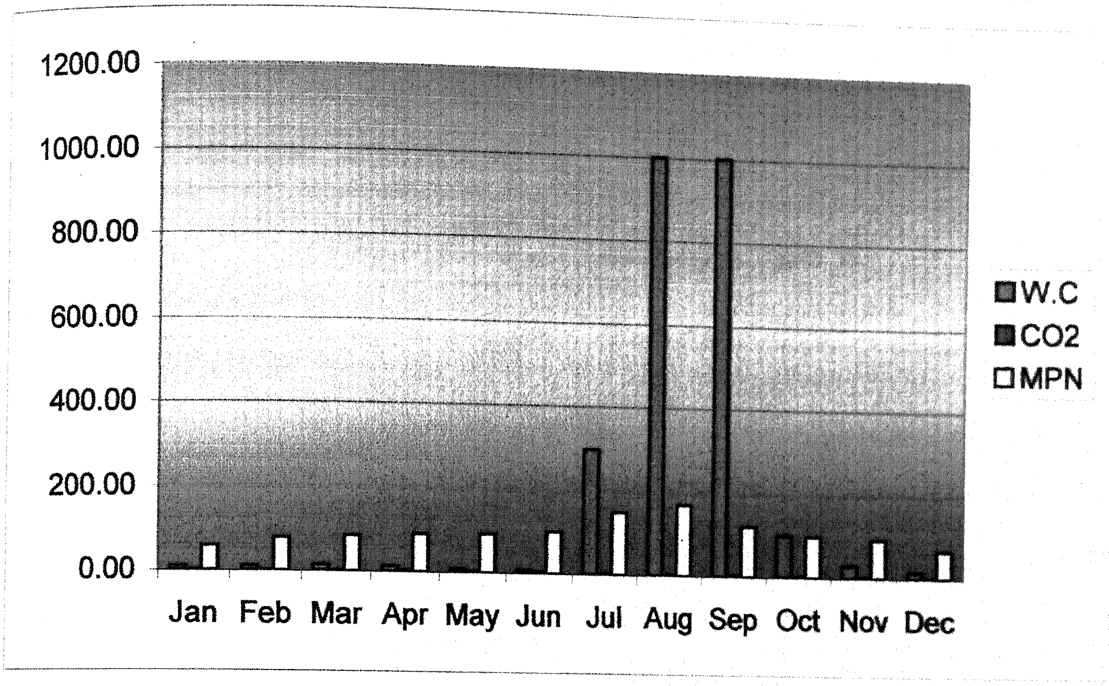


Fig-61

Station No. 2

Year- 2005

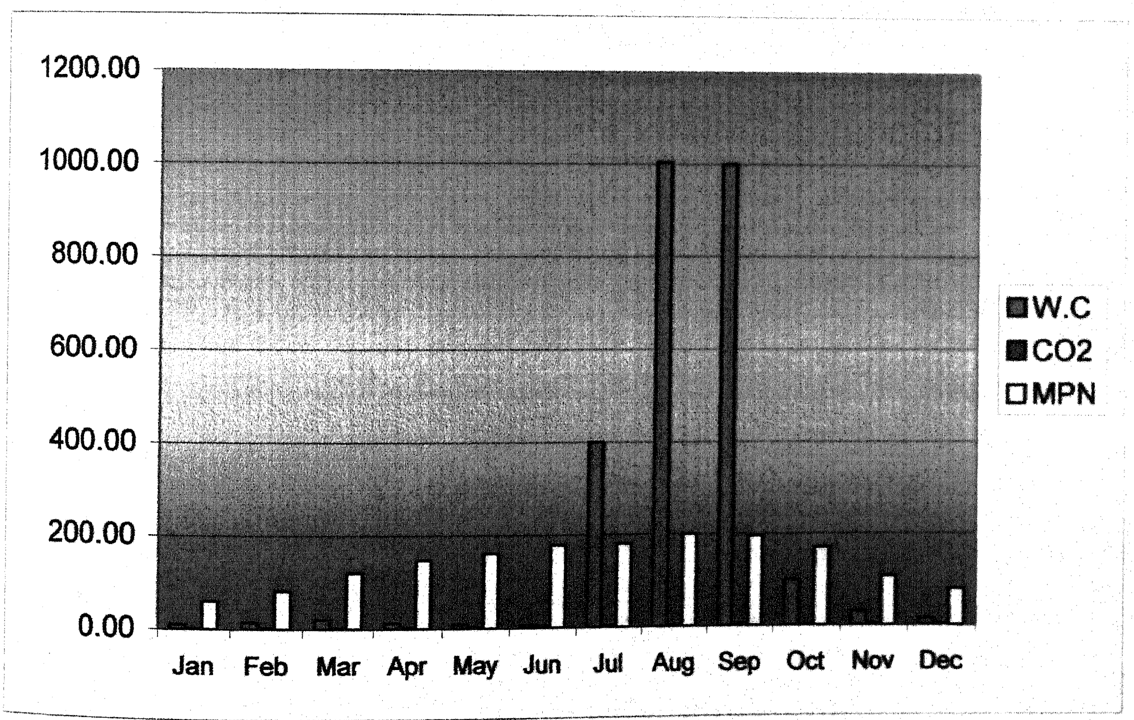


Fig-62

Water Current, Carbon-di-Oxide (CO_2) & M.P.N.

Station No. 3

Year- 2005

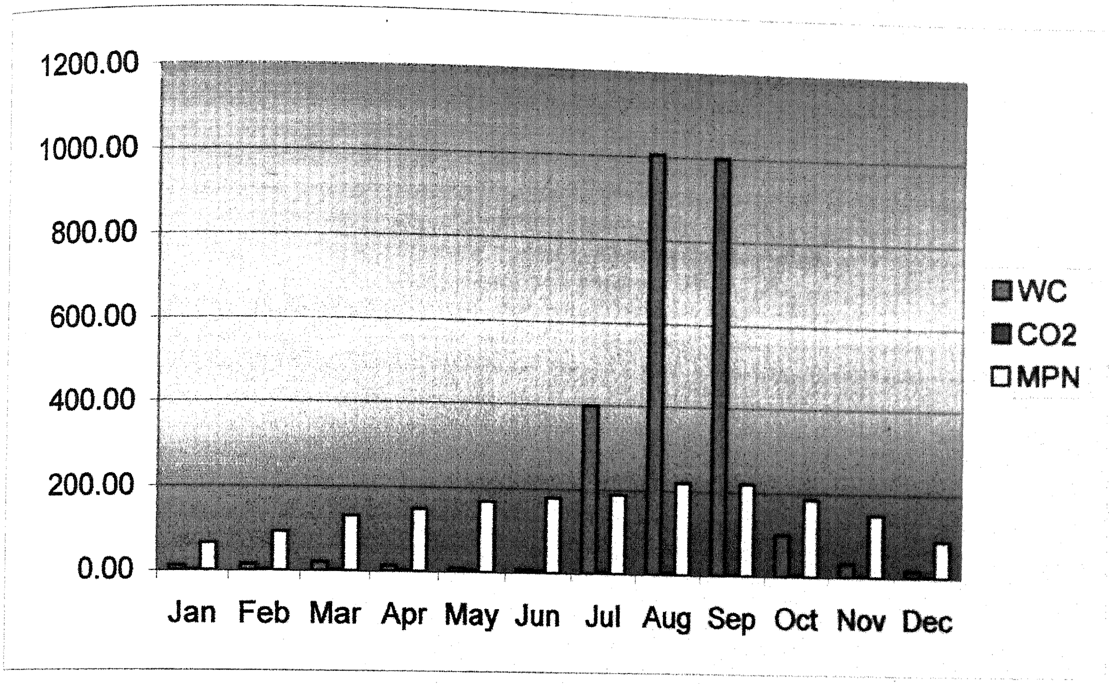


Fig-63

Station No. 4

Year- 2005

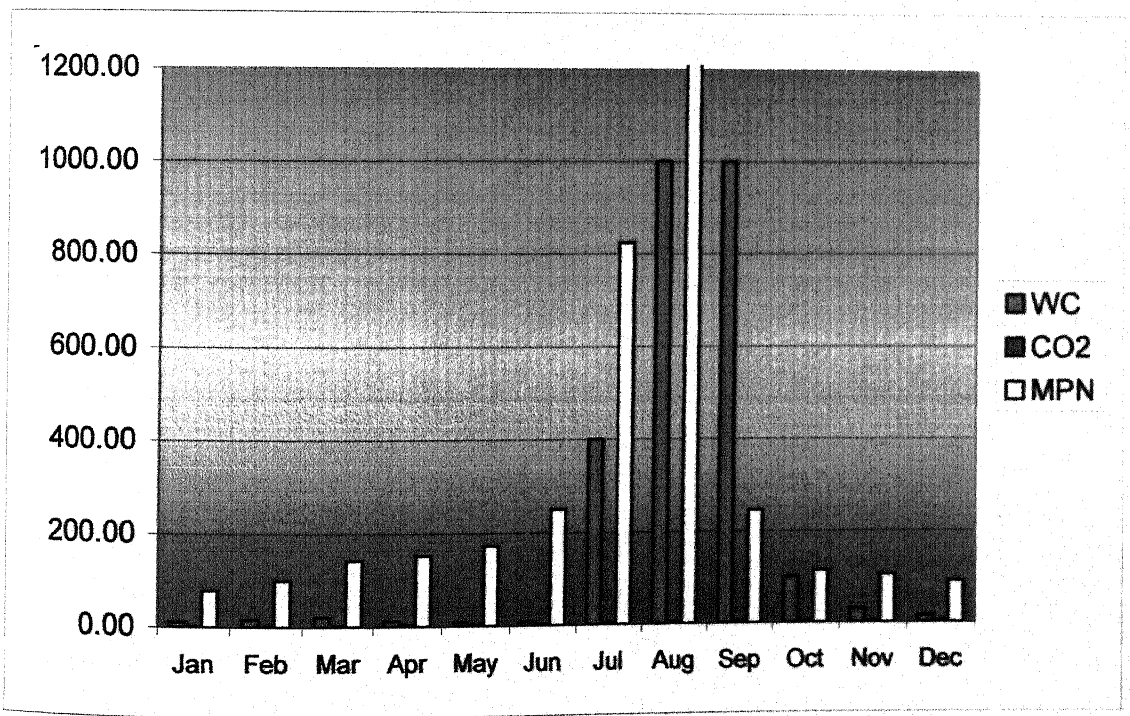


Fig-64

Water Current, Carbon-di-Oxide (CO_2) & M.P.N.

Station No. 1

Year- 2006

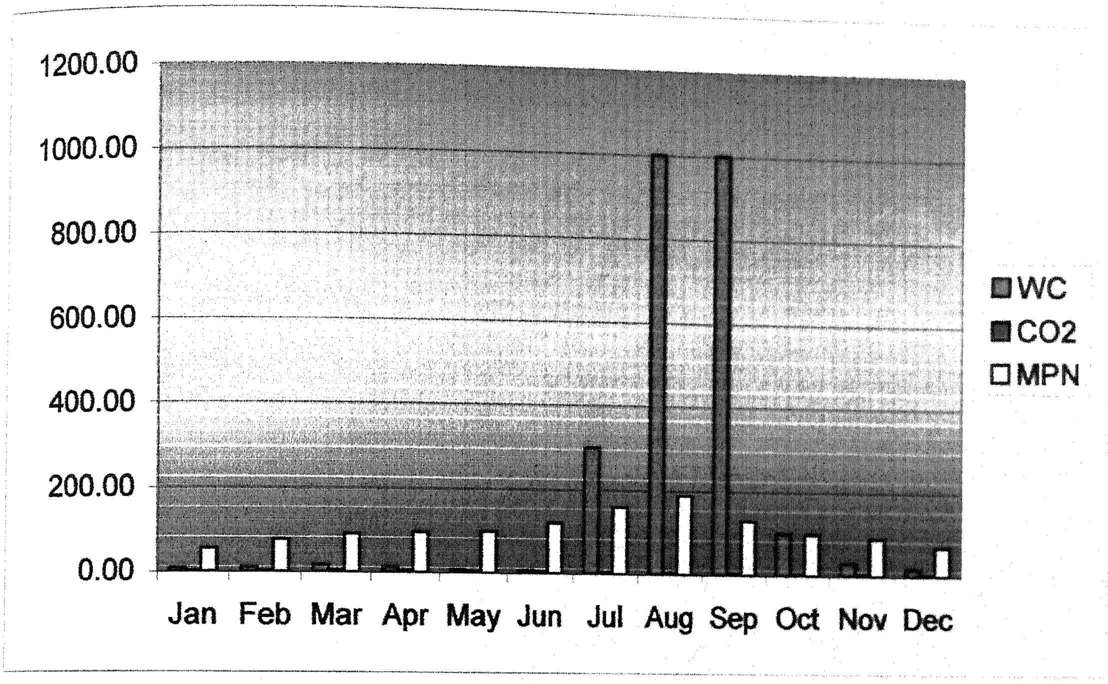


Fig-65

Station No. 2

Year- 2006

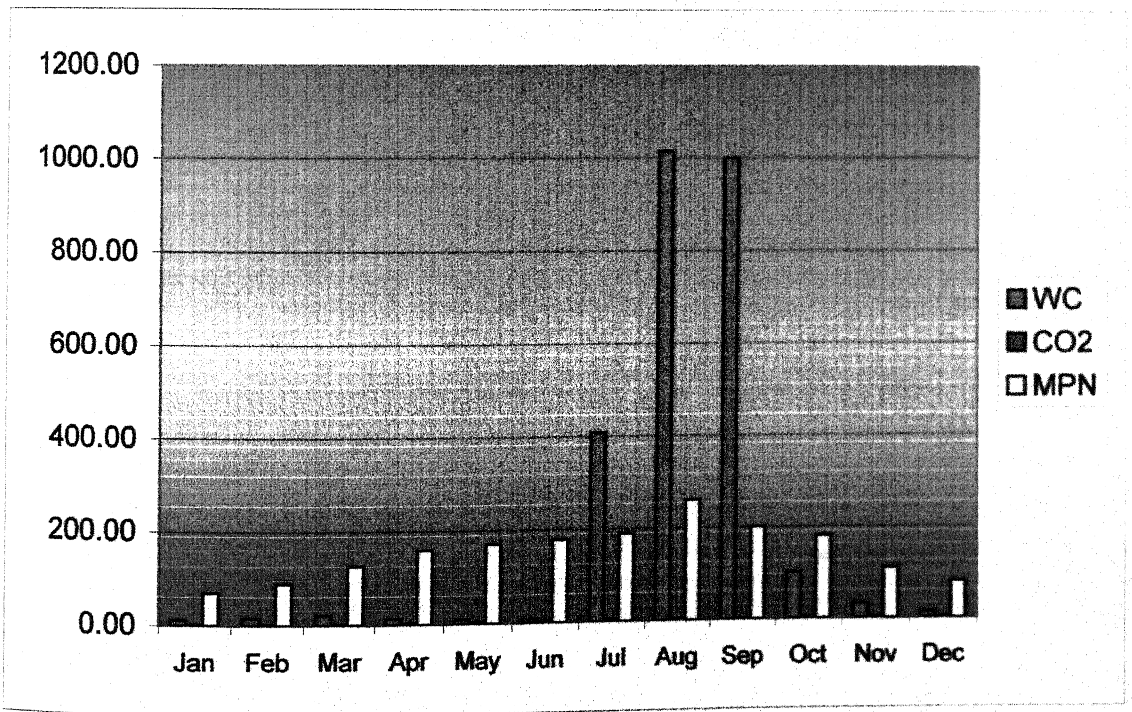


Fig-66

Water Current, Carbon-di-Oxide (CO_2) & M.P.N.

Station No. 3 **Year- 2006**

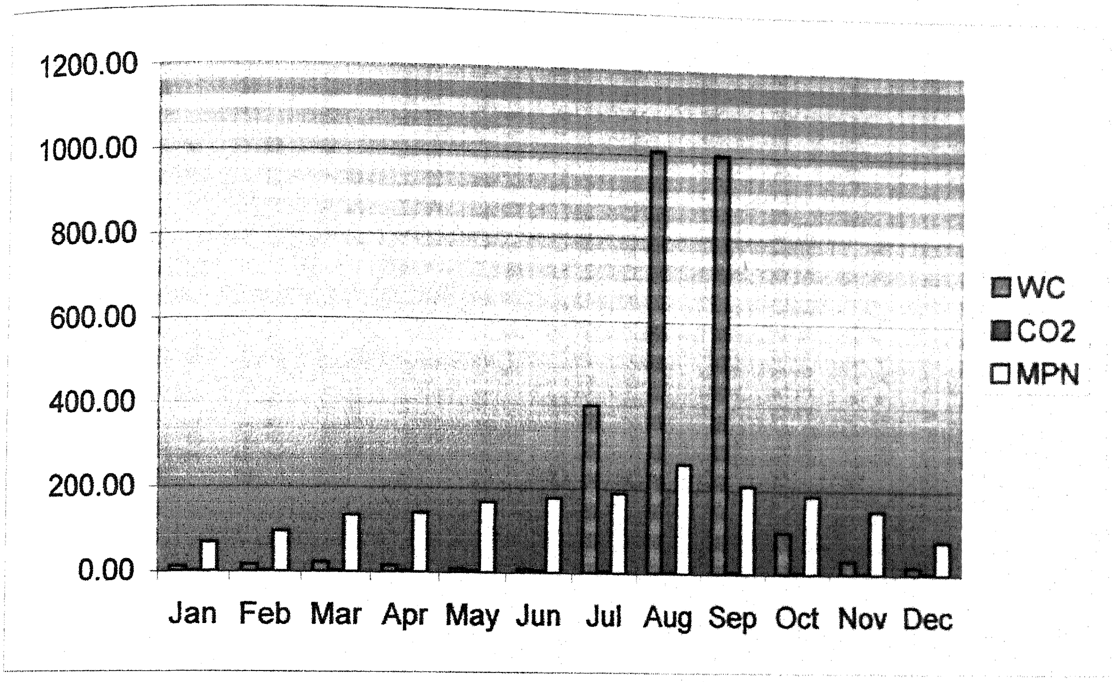


Fig- 67

Station No. 4 **Year- 2006**

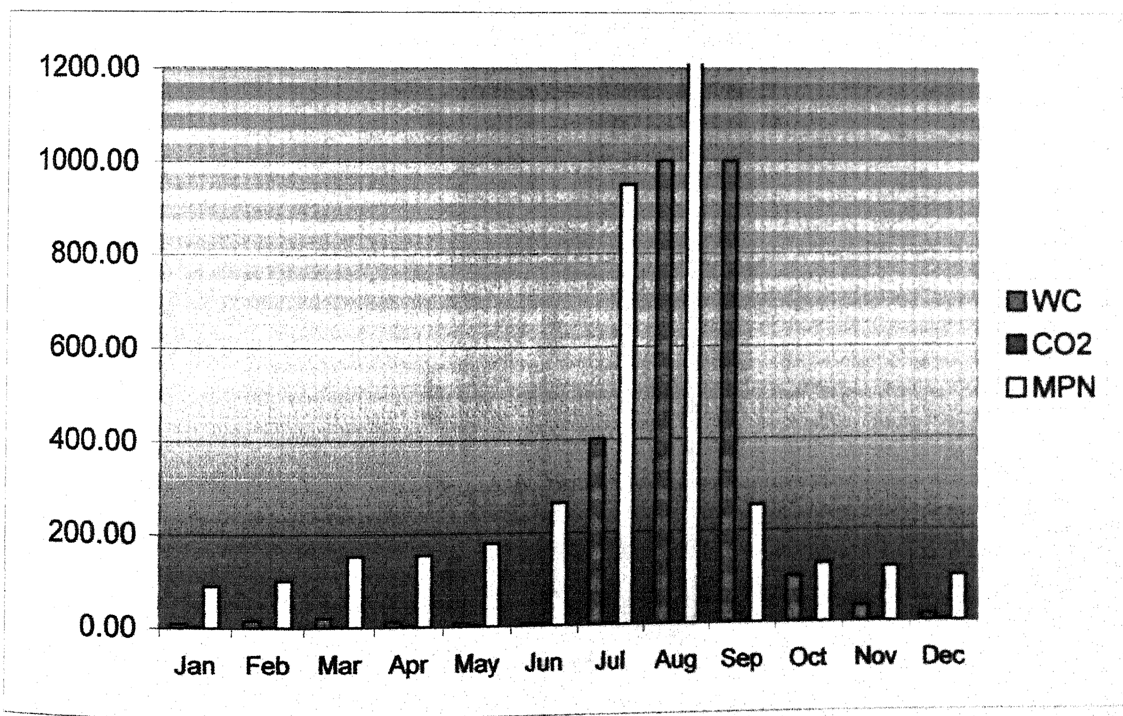


Fig-68

Station No-1

Phytoplankton
Year 2005

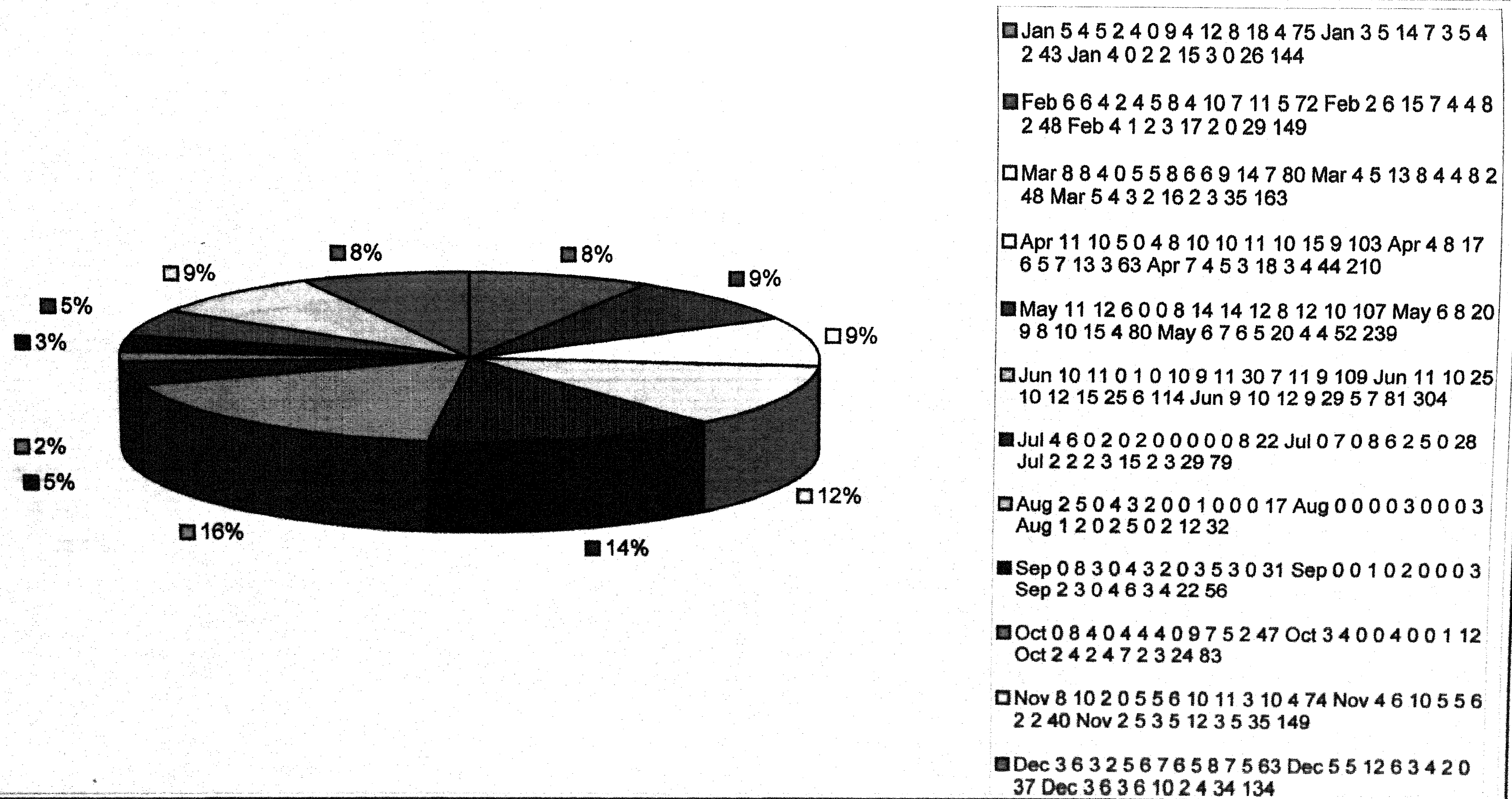
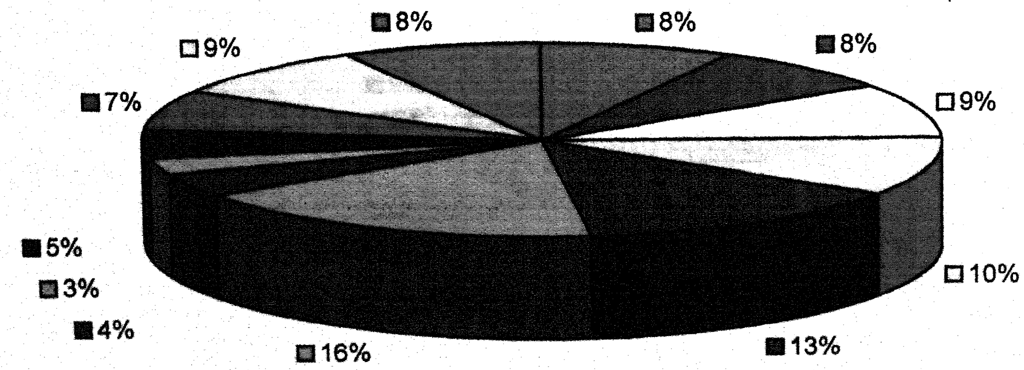


Fig. 69

Station No-2

Phytoplankton
Year 2005

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium



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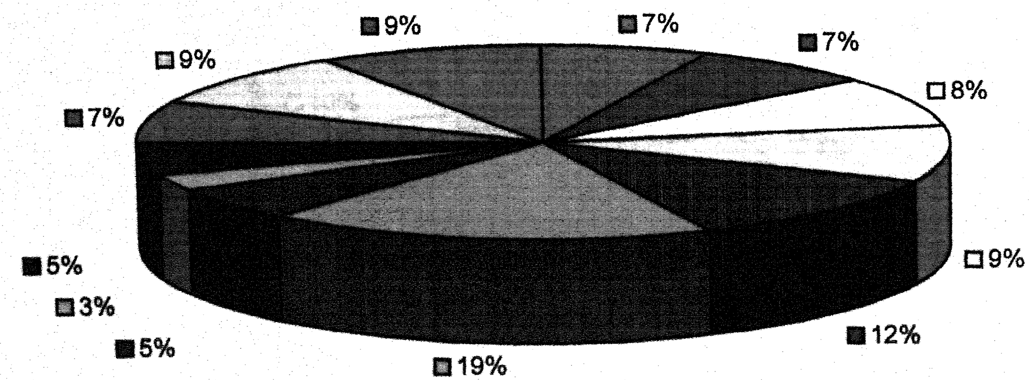
- Mar 7 9 5 3 5 5 9 7 6 17 12 8 93 Mar 6 0 8 5 4 15 6 4 42 Mar 3 6 3 2 18 2 0 34 169
- Apr 10 9 6 0 4 7 12 12 7 16 15 10 108 Apr 5 4 8 8 6 15 7 5 53 Apr 5 7 4 2 16 3 0 37 198
- May 12 12 10 0 4 8 15 12 13 20 14 12 132 May 11 5 9 11 16 20 6 5 72 May 7 11 7 3 30 4 2 64 268
- Jun 13 14 12 0 7 11 8 13 31 25 12 8 154 Jun 11 6 18 17 4 25 15 9 94 Jun 8 13 15 4 34 6 4 84 332
- Jul 3 4 0 2 0 2 0 5 0 5 0 8 29 Jul 0 2 8 4 1 2 4 0 21 Jul 8 1 0 0 18 0 0 27 77
- Aug 2 3 0 2 0 2 0 4 2 4 0 3 22 Aug 0 2 3 3 2 2 1 0 13 Aug 1 1 0 0 15 0 0 17 52
- Sep 4 4 0 4 3 5 0 6 3 3 3 2 37 Sep 0 1 3 2 9 12 2 1 30 Sep 1 2 0 7 12 2 1 25 92
- Oct 5 4 4 6 2 5 4 8 6 8 5 2 59 Oct 2 2 4 3 14 12 4 2 41 Oct 2 4 2 1 20 2 0 31 131
- Nov 9 8 5 5 4 6 5 10 9 7 8 4 80 Nov 3 2 5 5 13 11 6 2 44 Nov 3 6 1 2 24 3 2 41 165
- Dec 4 7 4 3 5 4 6 6 5 9 7 5 65 Dec 2 0 6 4 14 13 8 4 49 Dec 3 7 3 2 22 4 3 44 158

Fig. 70

Station No-3

Phytoplankton
Year 2005

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium



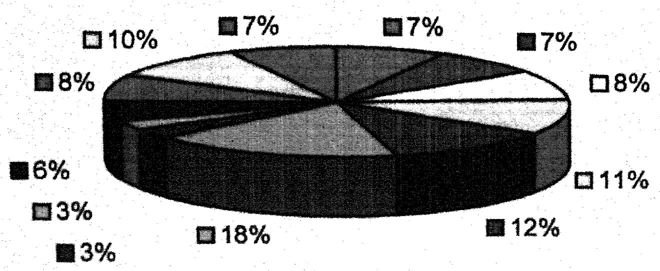
- Jan 2 0 4 1 6 2 6 2 8 10 20 3 64 Jan 2 0 0 1 2 3 1 0 7 Jan 3 3 0 4 18 0 5 33 104
- Feb 4 0 4 3 4 4 6 2 7 20 17 2 73 Feb 4 0 1 0 3 2 1 0 7 Feb 5 3 0 2 20 0 5 35 115
- Mar 5 0 5 2 5 5 4 3 6 22 13 5 75 Mar 4 0 2 0 4 3 3 2 14 Mar 2 4 3 4 20 2 8 43 132
- Apr 5 0 7 0 5 6 8 5 7 22 12 8 85 Apr 5 2 2 4 6 4 2 0 20 Apr 5 5 2 5 18 2 7 44 149
- May 6 2 6 0 7 8 8 10 11 19 15 4 96 May 7 3 3 5 8 5 8 3 35 May 6 6 5 8 16 4 8 53 184
- Jun 12 3 5 0 18 15 18 9 20 21 12 7 140 Jun 8 0 11 8 10 9 12 4 54 Jun 9 10 12 9 29 5 18 92 286
- Jul 3 4 4 3 0 3 5 2 4 4 1 2 35 Jul 8 0 2 2 0 3 0 2 9 Jul 9 2 2 2 12 0 15 42 86
- Aug 2 1 3 2 0 2 4 2 1 3 0 0 20 Aug 0 0 3 0 0 2 0 0 5 Aug 1 2 1 0 10 0 6 20 45
- Sep 6 0 4 4 2 3 5 4 3 8 3 0 42 Sep 0 1 1 0 0 2 4 3 11 Sep 0 3 1 1 18 3 4 30 83
- Oct 5 0 5 5 4 6 7 6 5 12 5 0 60 Oct 0 2 3 1 1 4 4 2 17 Oct 2 4 2 0 16 4 6 34 111
- Nov 6 0 6 6 5 8 6 5 8 11 9 4 74 Nov 3 3 4 2 4 5 2 3 23 Nov 3 5 3 4 21 2 8 46 143
- Dec 4 0 7 3 3 8 10 8 6 14 8 5 76 Dec 2 2 3 1 3 6 3 2 20 Dec 3 4 2 7 22 1 7 46 142

Fig. 71

Station No-4

Phytoplankton
Year 2005

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium



Jan 2 3 6 3 5 4 0 4 7 17 16 5 72 Jan 4 2 3 1 2 3 3 0 14 Jan 3 6 0 4 3 2 5 23 109

Feb 5 6 7 2 6 5 0 6 7 18 10 6 78 Feb 3 3 2 0 2 4 2 0 13 Feb 2 5 0 2 5 1 4 19 110

Mar 5 8 5 2 6 6 0 7 6 23 13 4 85 Mar 6 4 5 0 3 4 3 0 19 Mar 3 6 0 3 4 2 3 21 125

Apr 6 7 6 3 7 8 2 12 8 25 15 6 105 Apr 6 2 4 3 4 3 4 2 22 Apr 4 8 1 4 3 4 5 29 156

May 7 9 8 0 8 12 3 12 10 20 12 7 108 May 5 3 6 3 5 5 7 3 32 May 5 10 2 4 2 5 8 36 176

Jun 9 11 13 0 12 15 4 14 20 21 12 16 147 Jun 10 6 9 5 7 8 10 4 49 Jun 7 12 4 8 4 10 15 60 256

Jul 2 2 4 0 2 1 1 3 0 5 0 3 23 Jul 0 2 1 0 2 2 0 0 7 Jul 0 1 0 3 1 2 6 13 43

Aug 1 1 2 1 4 2 2 1 2 4 0 2 22 Aug 0 1 0 0 1 3 0 0 5 Aug 0 1 0 2 2 3 5 13 40

Sep 3 3 6 3 5 4 2 8 4 6 3 3 50 Sep 2 2 0 0 3 4 0 0 9 Sep 3 2 0 4 3 5 7 24 83

Oct 4 4 8 5 7 5 3 10 6 12 5 2 71 Oct 2 2 1 2 2 3 5 0 15 Oct 4 4 2 3 4 6 9 32 118

Nov 5 6 9 6 6 6 2 11 5 15 8 3 82 Nov 1 4 2 4 2 2 6 2 22 Nov 5 6 3 6 5 7 10 42 146

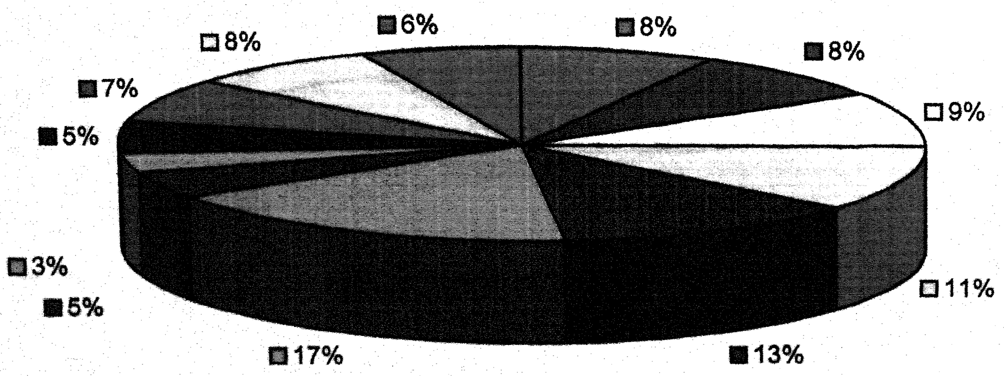
Dec 4 4 6 4 4 4 1 5 4 11 9 5 61 Dec 2 3 2 0 3 4 4 3 19 Dec 3 7 2 4 3 5 6 30 110

Fig. 72

Station No-1

Phytoplankton
Year 2006

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium



Jan 4 5 1 3 3 0 10 2 11 18 19 4 80 Jan 4 0 8 2 3 4 5 0 22 Jan 3 4 2 3 18 3 0 33 135

Feb 6 6 2 4 4 0 8 6 8 20 14 5 83 Feb 3 0 7 4 2 5 8 0 26 Feb 2 5 2 4 16 5 0 34 143

Mar 7 7 0 5 5 3 8 10 4 16 13 3 81 Mar 3 3 9 6 4 5 8 2 37 Mar 4 6 2 4 17 5 3 41 159

Apr 10 11 0 4 4 5 9 13 9 19 15 3 102 Apr 4 3 10 5 4 6 14 4 46 Apr 5 6 3 5 20 4 3 46 194

May 12 14 0 0 0 5 12 14 12 20 13 0 102 May 6 6 14 7 6 8 16 5 62 May 8 8 4 8 18 7 5 58 222

Jun 15 14 0 0 0 8 13 6 31 24 10 0 121 Jun 10 9 18 13 10 14 18 5 87 Jun 12 11 8 10 30 14 8 93 301

Jul 5 3 1 0 0 2 5 4 0 6 0 0 26 Jul 2 2 4 0 3 5 8 0 22 Jul 4 1 2 5 15 2 3 32 80

Aug 2 2 2 2 2 1 4 7 3 2 0 0 27 Aug 2 0 5 0 3 4 6 0 18 Aug 2 1 2 0 4 0 2 11 56

Sep 3 5 4 5 5 3 5 8 3 6 0 4 51 Sep 4 1 6 0 5 6 7 2 27 Sep 3 2 4 0 4 0 4 17 95

Oct 7 6 6 4 4 2 7 8 7 8 4 4 67 Oct 5 3 4 4 8 5 6 4 34 Oct 4 3 3 0 8 3 5 26 127

Nov 8 7 3 2 2 4 5 10 9 10 6 2 68 Nov 6 2 7 5 6 8 9 3 40 Nov 3 4 2 4 8 2 3 26 134

Dec 4 3 2 3 3 3 4 3 4 12 9 3 53 Dec 3 2 8 2 2 6 10 4 34 Dec 5 3 3 3 7 4 2 27 114

Fig. 73

Station No-2

Phytoplankton
Year 2006

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospermum, Rivularia, Microcoleus, Vaucharia, Phormidium

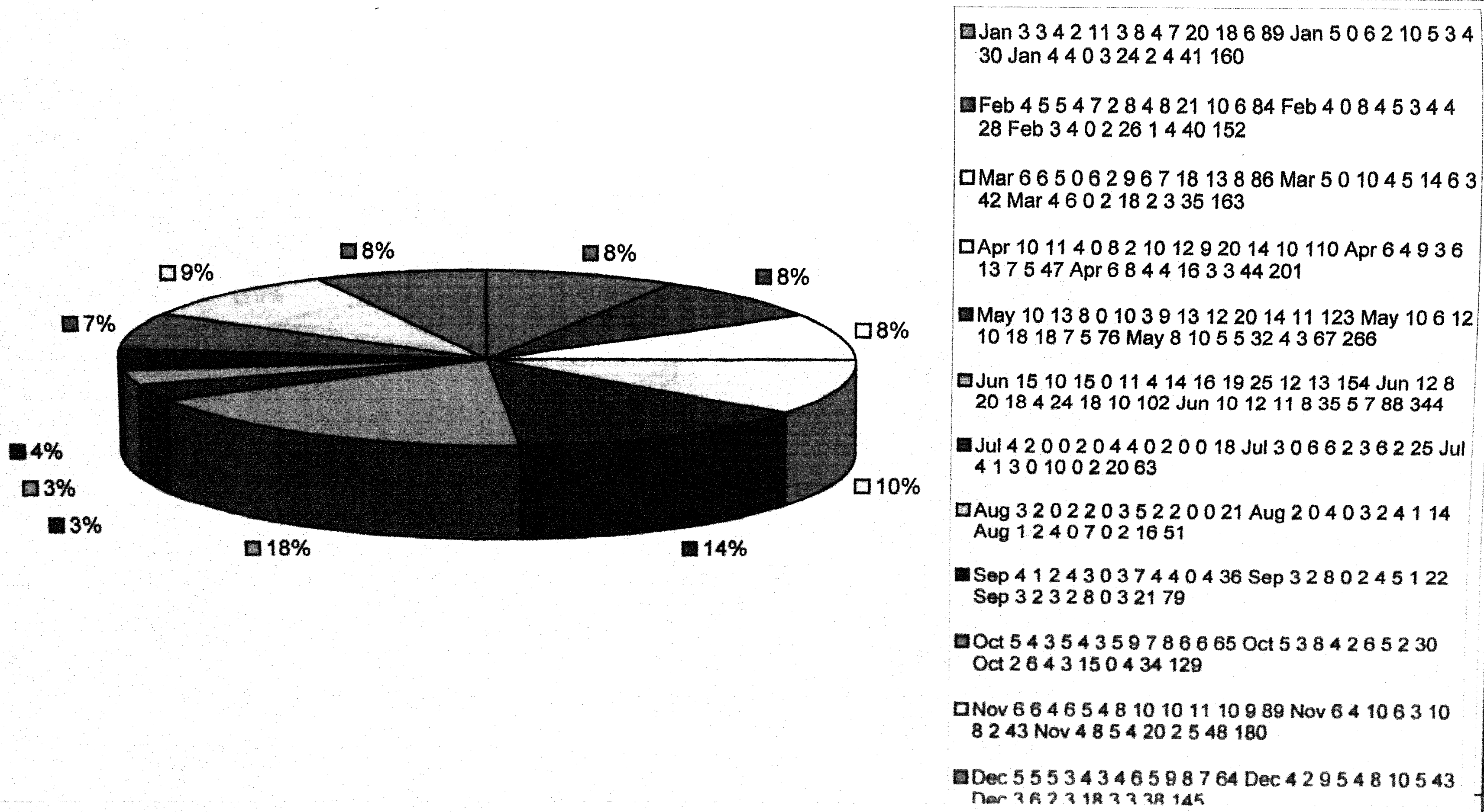


Fig. 74

Station No-3

Phytoplankton
Year 2006

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium

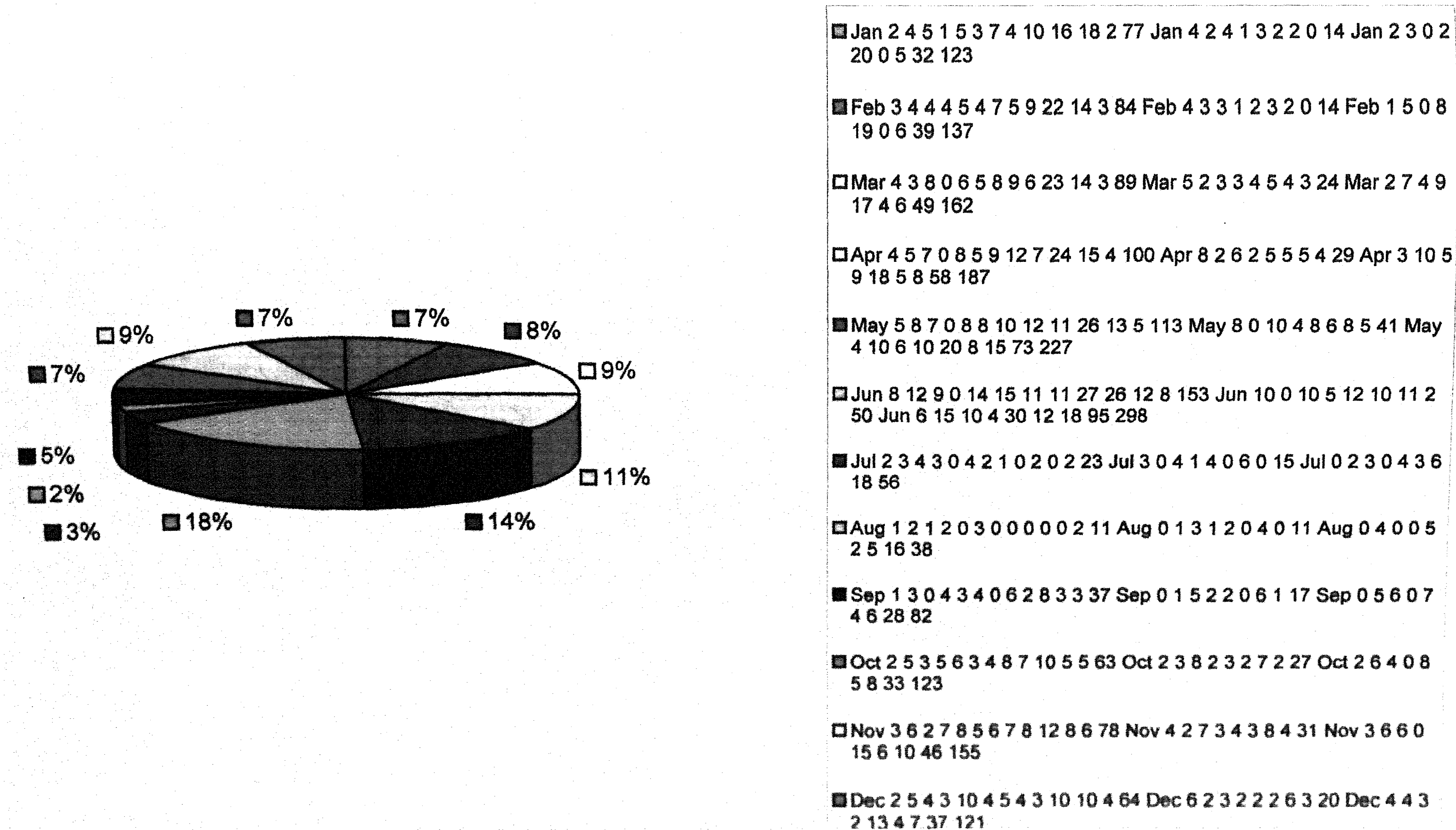


Fig. 75

Phytoplankton
Year 2006

Chlorophyceae-Ankistrodesmus, Chlorella, Cosmarium, Eudorina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra , Ulothrix, Zygnema, Becillariophyceae-Amphipleura, Coconies, Fragillaria, Gomphonema, Nitchia Palaea, Synedraacus, Tabelloeria, Pinnularia, Cynophyceae-Agmenellum, Anabaena, Cylinderospernum, Rivularia, Microcoleus, Vaucharia, Phormidium

Station No-4

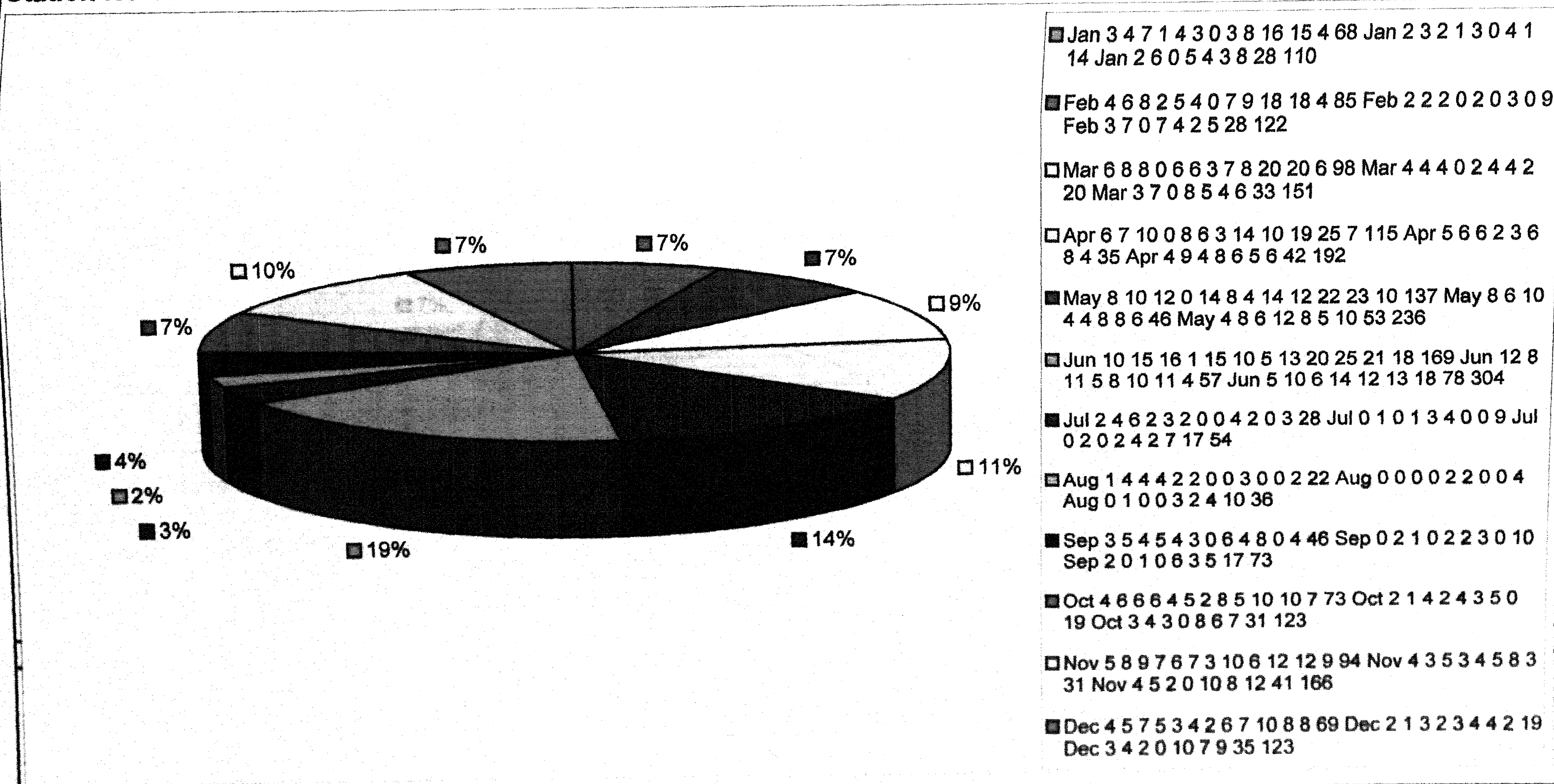


Fig. 76

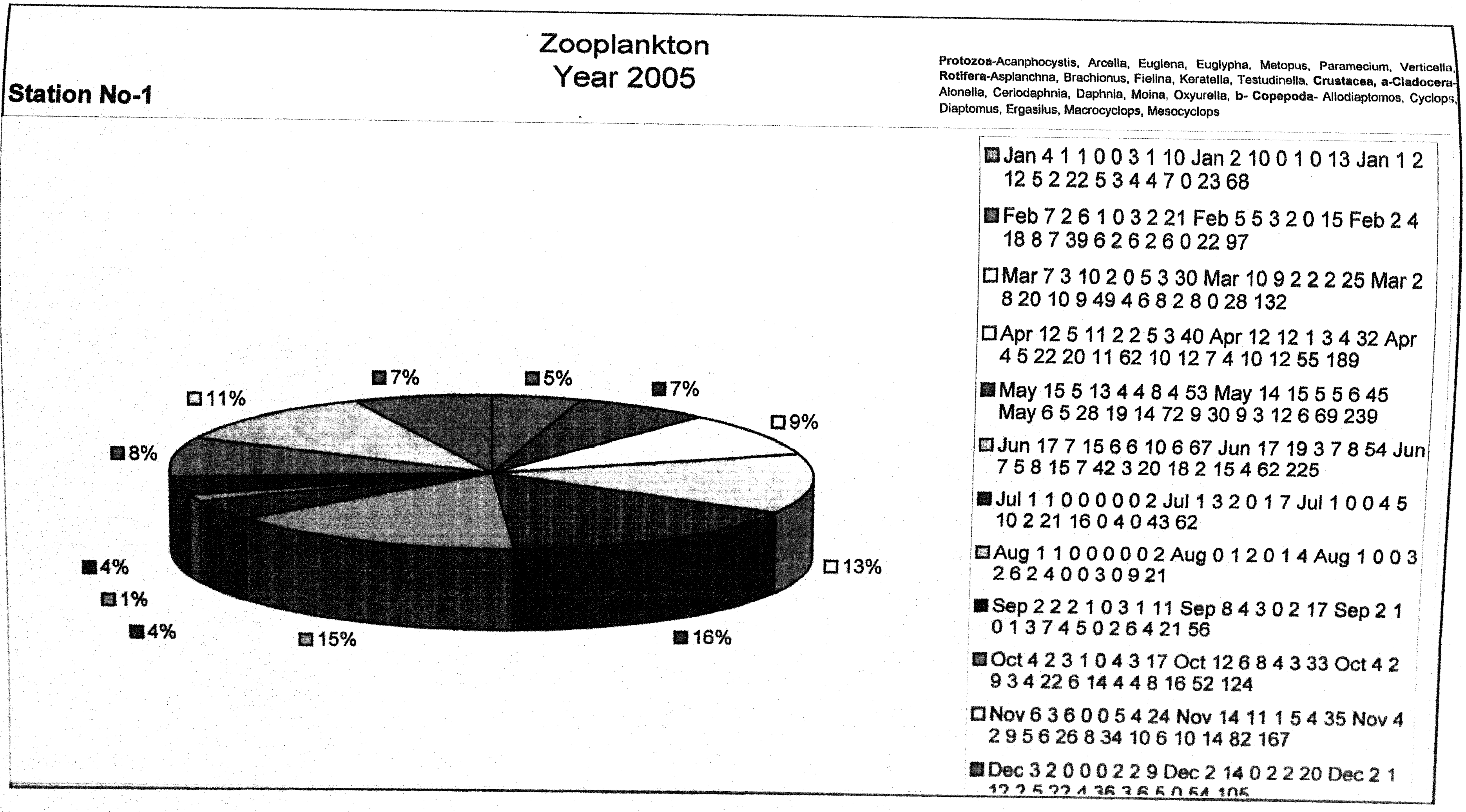

Station No-1
Zooplankton
Year 2005
Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, Rotifera-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, Crustacea, a-Cladocera-Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, b- Copepoda- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops
Jan 4 1 1 0 0 3 1 10 Jan 2 10 0 1 0 13 Jan 1 2 12 5 2 22 5 3 4 4 7 0 23 68
Feb 7 2 6 1 0 3 2 21 Feb 5 5 3 2 0 15 Feb 2 4 18 8 7 39 6 2 6 2 6 0 22 97
Mar 7 3 10 2 0 5 3 30 Mar 10 9 2 2 2 25 Mar 2 8 20 10 9 49 4 6 8 2 8 0 28 132
Apr 12 5 11 2 2 5 3 40 Apr 12 12 1 3 4 32 Apr 4 5 22 20 11 62 10 12 7 4 10 12 55 189
May 15 5 13 4 4 8 4 53 May 14 15 5 5 6 45 May 6 5 28 19 14 72 9 30 9 3 12 6 69 239
Jun 17 7 15 6 6 10 6 67 Jun 17 19 3 7 8 54 Jun 7 5 8 15 7 42 3 20 18 2 15 4 62 225
Jul 1 1 0 0 0 0 0 2 Jul 1 3 2 0 1 7 Jul 1 0 0 4 5 10 2 21 16 0 4 0 43 62
Aug 1 1 0 0 0 0 0 2 Aug 0 1 2 0 1 4 Aug 1 0 0 3 2 6 2 4 0 0 3 0 9 21
Sep 2 2 2 1 0 3 1 11 Sep 8 4 3 0 2 17 Sep 2 1 0 1 3 7 4 5 0 2 6 4 21 56
Oct 4 2 3 1 0 4 3 17 Oct 12 6 8 4 3 33 Oct 4 2 9 3 4 22 6 14 4 4 8 16 52 124
Nov 6 3 6 0 0 5 4 24 Nov 14 11 1 5 4 35 Nov 4 2 9 5 6 26 8 34 10 6 10 14 82 167
Dec 3 2 0 0 0 2 2 9 Dec 2 14 0 2 2 20 Dec 2 1
7%
5%
7%
11%
9%
8%
13%
4%
1%
4%
15%
16%

Fig. 77

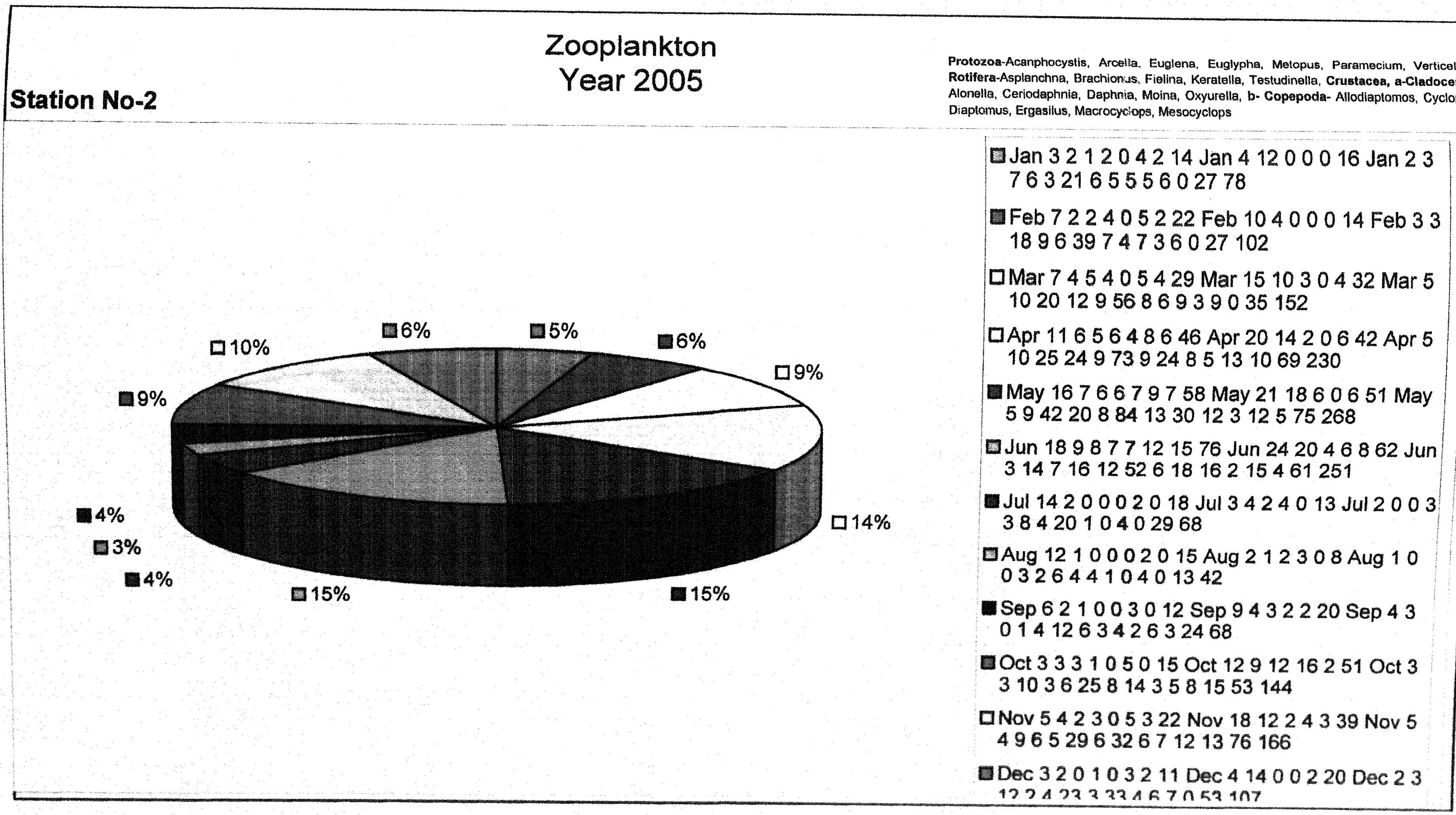
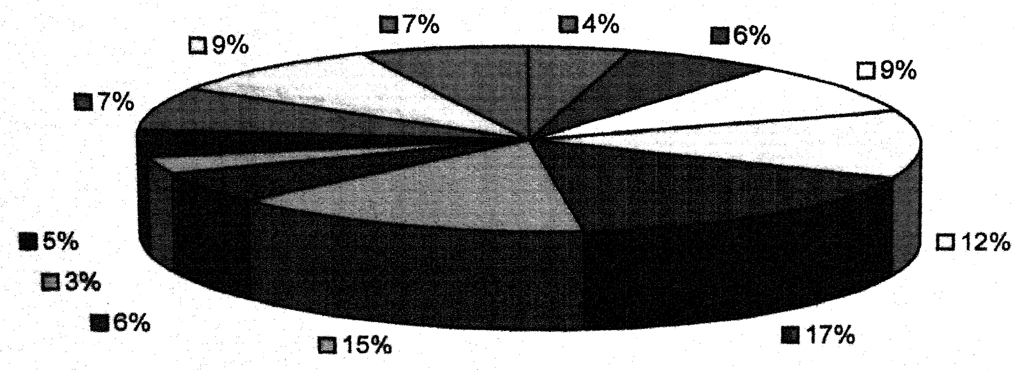

Station No-2
Zooplankton
Year 2005
Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, Rotifera-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, Crustacea, a-Cladocera-Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, b- Copepoda- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops
10%
6%
5%
6%
9%
9%
14%
4%
3%
4%
15%
15%
Jan 3 2 1 2 0 4 2 14 Jan 4 12 0 0 0 16 Jan 2 3 7 6 3 21 6 5 5 5 6 0 27 78
Feb 7 2 2 4 0 5 2 22 Feb 10 4 0 0 0 14 Feb 3 3 18 9 6 39 7 4 7 3 6 0 27 102
Mar 7 4 5 4 0 5 4 29 Mar 15 10 3 0 4 32 Mar 5 10 20 12 9 56 8 6 9 3 9 0 35 152
Apr 11 6 5 6 4 8 6 46 Apr 20 14 2 0 6 42 Apr 5 10 25 24 9 73 9 24 8 5 13 10 69 230
May 16 7 6 6 7 9 7 58 May 21 18 6 0 6 51 May 5 9 42 20 8 84 13 30 12 3 12 5 75 268
Jun 18 9 8 7 7 12 15 76 Jun 24 20 4 6 8 62 Jun 3 14 7 16 12 52 6 18 16 2 15 4 61 251
Jul 14 2 0 0 0 2 0 18 Jul 3 4 2 4 0 13 Jul 2 0 0 3 3 8 4 20 1 0 4 0 29 68
Aug 12 1 0 0 0 2 0 15 Aug 2 1 2 3 0 8 Aug 1 0 0 3 2 6 4 4 1 0 4 0 13 42
Sep 6 2 1 0 0 3 0 12 Sep 9 4 3 2 2 20 Sep 4 3 0 1 4 12 6 3 4 2 6 3 24 68
Oct 3 3 3 1 0 5 0 15 Oct 12 9 12 16 2 51 Oct 3 3 10 3 6 25 8 14 3 5 8 15 53 144
Nov 5 4 2 3 0 5 3 22 Nov 18 12 2 4 3 39 Nov 5 4 9 6 5 29 6 32 6 7 12 13 76 166
Dec 3 2 0 1 0 3 2 11 Dec 4 14 0 0 2 20 Dec 2 3 12 2 4 23 3 33 4 6 7 0 53 107

Fig. 78

Station No-3

Zooplankton
Year 2005

Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, **Rotifera**-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, **Crustacea, a-Cladocera**- Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, **b- Copepoda**- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops



- Jan 2 2 2 1 0 3 2 12 Jan 4 16 5 2 1 28 Jan 3 3 6 2 2 16 5 5 4 4 5 0 23 79
- Feb 6 3 6 2 0 3 3 23 Feb 12 6 6 4 2 30 Feb 3 3 20 2 4 32 8 4 6 3 5 0 26 111
- Mar 5 4 6 4 0 5 5 29 Mar 16 11 12 6 0 45 Mar 7 10 24 3 10 54 7 8 8 4 10 0 37 165
- Apr 10 8 12 4 5 5 7 51 Apr 20 14 14 11 0 59 Apr 7 9 25 4 9 54 9 25 7 3 10 6 60 224
- May 15 11 15 6 8 8 7 70 May 24 20 16 12 8 80 May 7 12 48 6 12 85 10 30 10 2 10 9 71 306
- Jun 17 14 18 8 6 14 12 89 Jun 25 21 18 15 8 87 Jun 4 14 7 6 13 44 8 19 14 0 13 4 58 278
- Jul 18 1 20 0 0 2 0 41 Jul 2 2 20 3 2 29 Jul 2 0 0 2 3 7 3 22 0 0 3 0 28 105
- Aug 16 2 16 0 0 1 0 35 Aug 6 1 0 2 0 9 Aug 1 0 0 1 2 4 2 4 0 0 3 0 9 57
- Sep 5 2 5 2 0 3 0 17 Sep 10 5 0 5 0 20 Sep 4 2 0 2 5 13 16 3 5 3 6 4 37 87
- Oct 4 5 4 3 0 2 0 18 Oct 14 8 6 8 0 36 Oct 3 2 10 4 4 23 14 15 4 6 6 16 61 138
- Nov 6 4 6 0 0 3 2 21 Nov 16 15 8 7 2 48 Nov 6 6 9 6 8 35 5 30 6 8 7 15 71 175
- Dec 5 3 5 0 0 2 3 18 Dec 7 16 4 6 1 34 Dec 2 4 12 3 6 27 4 32 3 4 5 3 51 130

Fig. 79

Zooplankton
Year 2005

Station No-4

Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, **Rotifera**-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, **Crustacea, a-Cladocera**- Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, **b- Copepoda**- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops

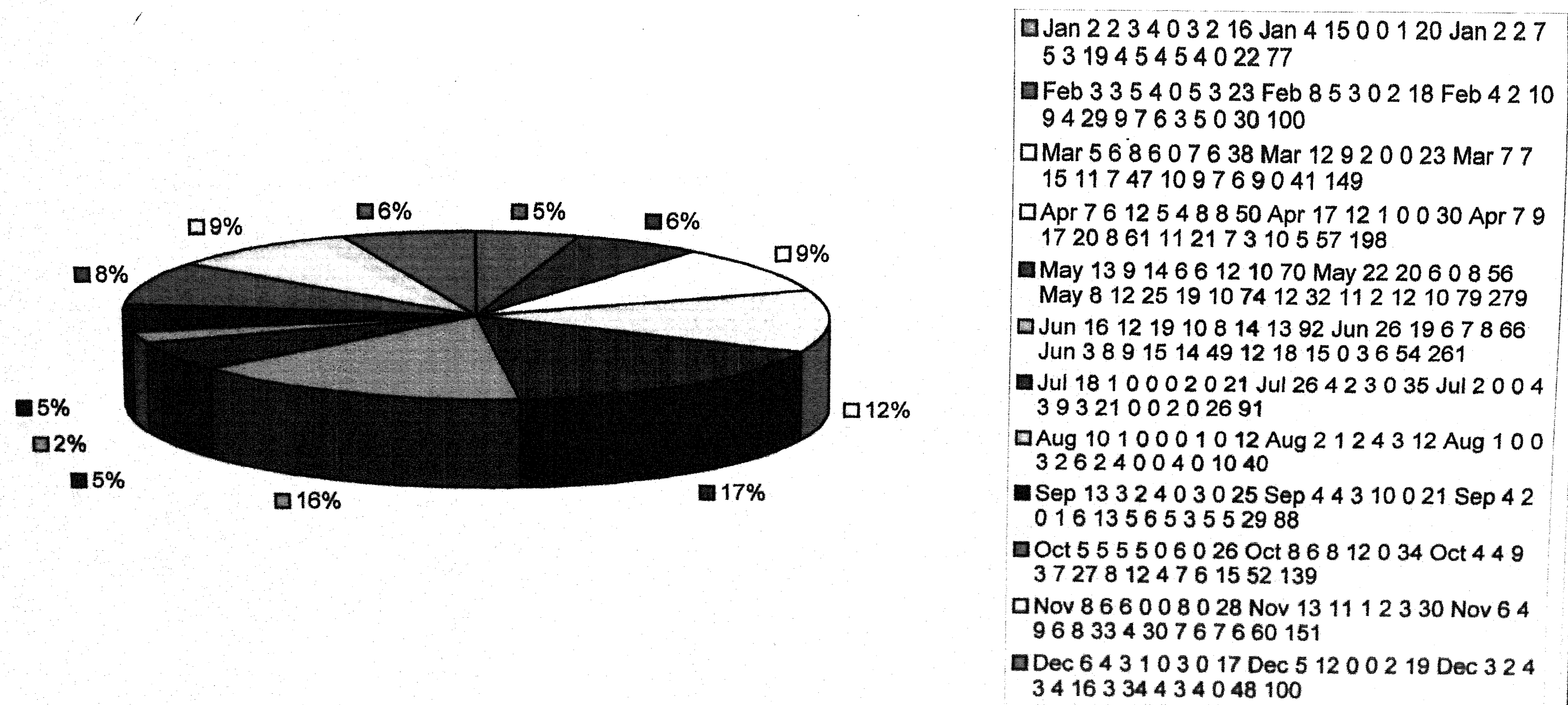


Fig. 80

Station No-1

Zooplankton
Year 2006

Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, **Rotifera**-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, **Crustacea, a-Cladocera**- Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, **b- Copepoda**- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops

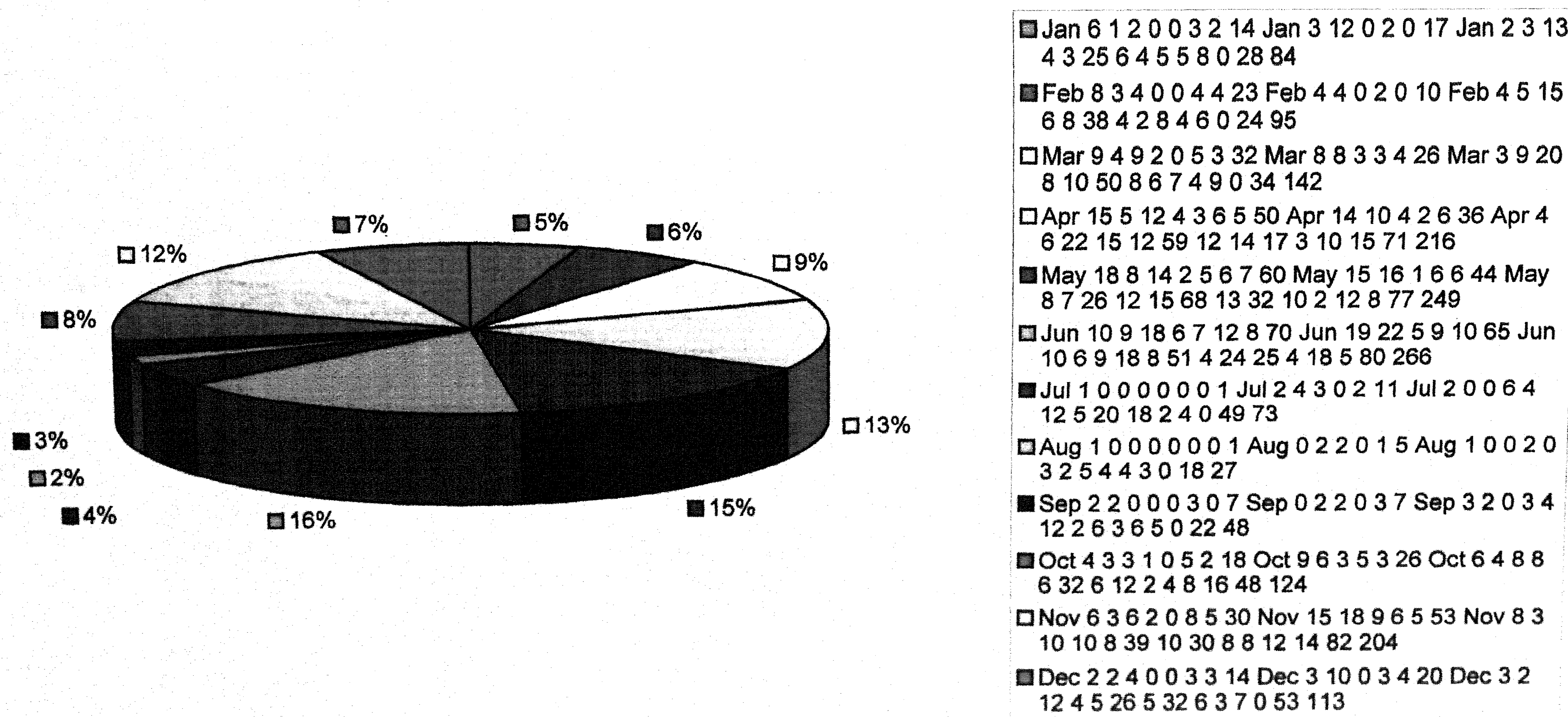


Fig. 81

Station No-2

Zooplankton
Year 2006

Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, **Rotifera**-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, **Crustacea, a-Cladocera**- Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, **b- Copepoda**- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops

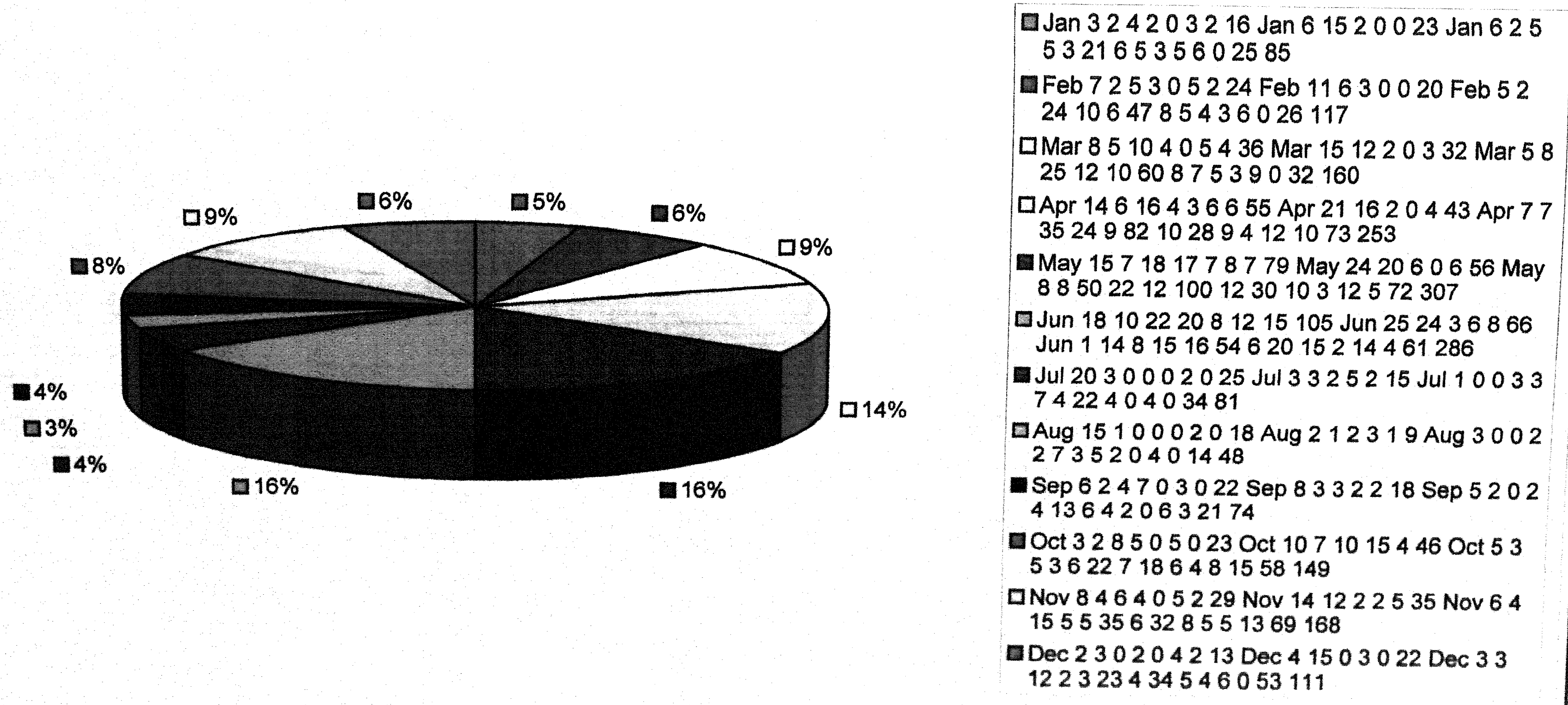


Fig. 82

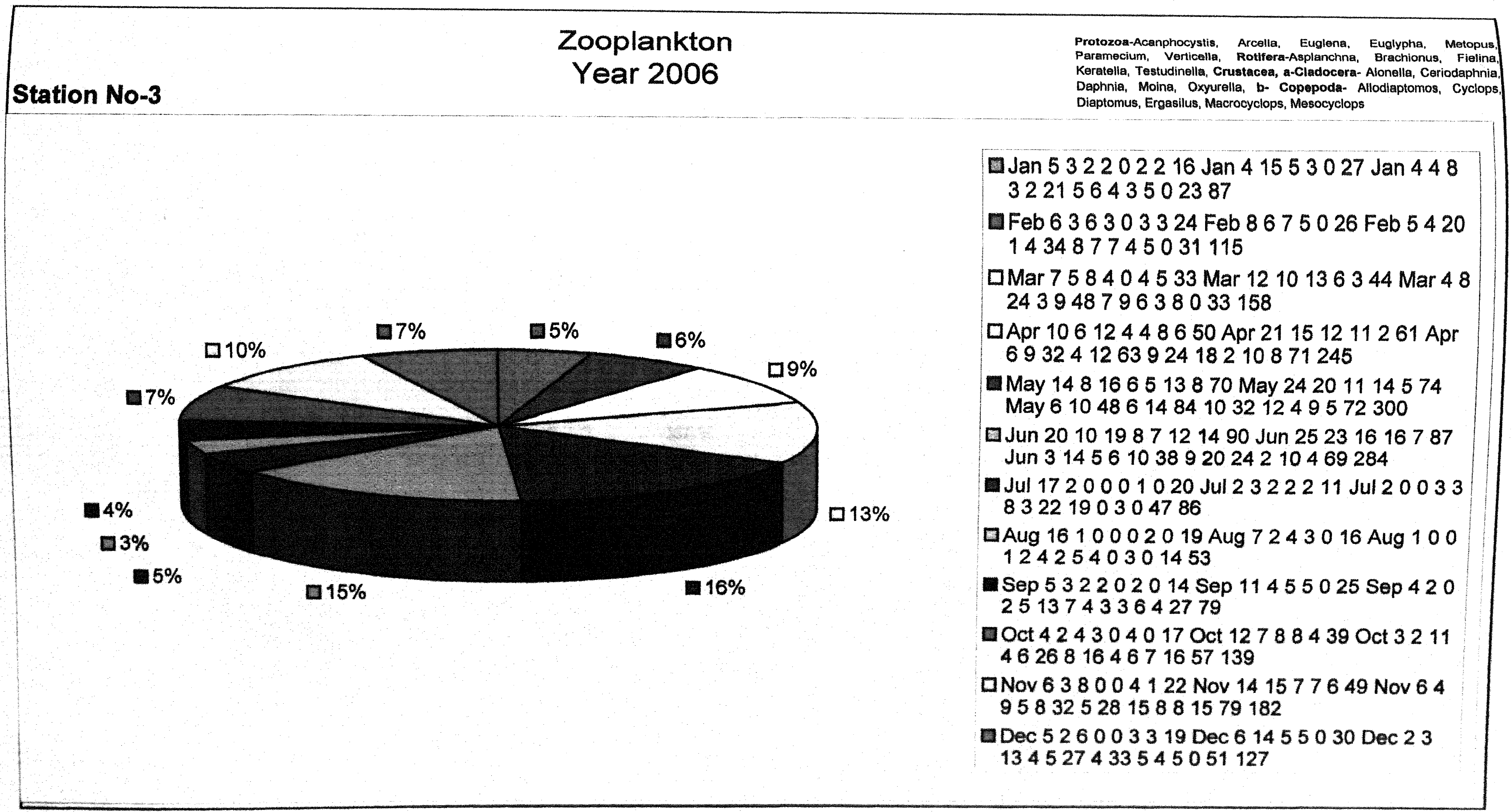

Station No-3
Zooplankton
Year 2006
Protozoa-Acanphocystis, Arcella, Euglena, Euglypha, Metopus, Paramecium, Verticella, Rotifera-Asplanchna, Brachionus, Fielina, Keratella, Testudinella, Crustacea, a-Cladocera- Alonella, Ceriodaphnia, Daphnia, Moina, Oxyurella, b- Copepoda- Allodiaptomos, Cyclops, Diaptomus, Ergasilus, Macrocyclops, Mesocyclops
10%
7%
5%
6%
9%
7%
4%
3%
5%
15%
16%
13%
Jan 5 3 2 2 0 2 2 16 Jan 4 15 5 3 0 27 Jan 4 4 8 3 2 21 5 6 4 3 5 0 23 87
Feb 6 3 6 3 0 3 3 24 Feb 8 6 7 5 0 26 Feb 5 4 20 1 4 34 8 7 7 4 5 0 31 115
Mar 7 5 8 4 0 4 5 33 Mar 12 10 13 6 3 44 Mar 4 8 24 3 9 48 7 9 6 3 8 0 33 158
Apr 10 6 12 4 4 8 6 50 Apr 21 15 12 11 2 61 Apr 6 9 32 4 12 63 9 24 18 2 10 8 71 245
May 14 8 16 6 5 13 8 70 May 24 20 11 14 5 74 May 6 10 48 6 14 84 10 32 12 4 9 5 72 300
Jun 20 10 19 8 7 12 14 90 Jun 25 23 16 16 7 87 Jun 3 14 5 6 10 38 9 20 24 2 10 4 69 284
Jul 17 2 0 0 0 1 0 20 Jul 2 3 2 2 2 11 Jul 2 0 0 3 3 8 3 22 19 0 3 0 47 86
Aug 16 1 0 0 0 2 0 19 Aug 7 2 4 3 0 16 Aug 1 0 0 1 2 4 2 5 4 0 3 0 14 53
Sep 5 3 2 2 0 2 0 14 Sep 11 4 5 5 0 25 Sep 4 2 0 2 5 13 7 4 3 3 6 4 27 79
Oct 4 2 4 3 0 4 0 17 Oct 12 7 8 8 4 39 Oct 3 2 11 4 6 26 8 16 4 6 7 16 57 139
Nov 6 3 8 0 0 4 1 22 Nov 14 15 7 7 6 49 Nov 6 4 9 5 8 32 5 28 15 8 8 15 79 182
Dec 5 2 6 0 0 3 3 19 Dec 6 14 5 5 0 30 Dec 2 3 13 4 5 27 4 33 5 4 5 0 51 127

Fig. 83

SUMMARY

SUMMARY

All life on earth depends upon water only a limited quantity of water is available on the earth. It is available from the natural resources in the form of rivers, lakes, ponds, reservairs seas, oceans and even ground water. Riverine ecology plays an important role to maintain hydrological cycle. India is fortunate in having several large rivers. The rivers of India depend upon the monsoon rainfal, which carry heavy flows during monsoon season.

The rivers having basin area between 2000 and 20000 sqm. are grounded as medium rivers and rest rivers are minor rivers besides there are 13 major river basins and as a group. These basins covers 80% population and 85% of total river discharge. Among the 45 medium rivers basins, four are international and eleven are interstate river basins. A total of 17 rivers having a combined basin area of 63500 Sq. Km. join, the Arabian sea. While remaining 24 rivers having a combined basin area of 210596 Sqkm. joins Bay of Bengal. The four rivers are originated in India but cross the national boundry, thus in corporate international river basin. Medium river basins are occupy 8% of total basin area and about 119940 million cubic meter water flows through these.

There are fifty five minor river basin having a combined basin area of about 2 Lacs sqkm. Most of these originate from Eastern and western ghats. The total area of minor basins is about 9% of total basin area of Indian rivers.

The river pollution is increasing in India due to muncipal solid wastes, sewage discharges, drains run off from croplands, industries and raising of population density river water is useful for humans for different purposes viz., drinking, irrigation, industrial processes, transportation, fish production along with other aquatic animals

habitat and waste disposal. These water resources are used to meet the day-to day requirements of human settlement.

As regards the river Mandakini which is a hilly river, and it is the last major tributary of river Yamuna before it joins river Ganga. It was worked out in Satna district of M.P. It is an interstate river between Madhya Pradesh & Uttar Pradesh which is its special feature in its topography. The total stretch of this river is 385Sq. km. The river basin lies between the latitude of 24^0.52 N and the longitude of 80^0 and 41E.

The river Mandakini originates near village Kalhaura in Majhgawn block, Dist. Satna of M.P. This river makes the border of Dist. Satna (M.P.) and Karwi D/S of Chitrakoot (U.P.). The river flows in a south to North direction. whereas in last reaches in west to east trend. The river Mandakini is a holy river. It's populary called "Mandakini Ganga" is life line of millions of people. It is believe to have shelter of Lord Ram for a long period during hhis exile. This fact has great importance and holiness not only to Chitrakoot but also to river Mandakini, which has been the prime water source since then.

The Physico -Chemical parameters of natural water are used as the direct or indirect indices of water pollution. The biological inventory presents reliable picture of the average situation. The reverence for rivers is derived from this basic recognition. However, over the years this tradition of reverence has been severely sullied. The Indian society, particularly the urban society has become a major pollutor. Cities compete with each other in desboilling the environment. Cities which grew and prospered on the banks of rivers have turned their backs on them and made the once golden streams into putrid drains.

The Mandakini rivers was observed for Physico-chemical and Biological and various factors in the period of Jan 2005 to Dec. 2006. Having in view the entire ecology of this river the quality of river water was analysed by selecting different sampling stations. The chemical and biological analysis of water samples were done as per methods of APHA (1998).

The metrological conditions viz atmospheric temprature, photoperiod, relative humidity and rain fall have direct impact on the aquatic factors.

The Physical factors are water temperature, water current, turbidity. Whereas the chemical factors are hydrogen-ion-concentration, total Alkalinity, total hardness, Calcium hardness, Magnesium hardness, Chloride, Dissolved oxygen, Bio-chemical oxygen demand Chemical Oxygen Demand, Ammonical nitrogen, Nitrite, Nitrate, Phosphate, Sulphate, Sodium, Potassium, Flouride; and the biological factors are total coliform (MPN), Plankton (Phyto and zooplankton), aquatic weeds and fish fauna studied in the present work.

All the meteorological conditions have direct impact on the river water besides Physical factors are also directly related to the meteorological conditions. Meteorological conditions and Physical factor have also direct impact chemical factor besides other causes.

For the chemical nature of the river water it was found alkaline with in the permissible range which is suitable for much fish production. The maximum value of pH was noticed 7.80 and minimum value was observed 7.00 in the month of January. The highest values was observed in summer season in the month of June due to the utilization of free CO_2 during active Photosynthesis. It was Hetropheustes fassilis, Showed maximum tolerance up to 11 pH whereas other fishes die off at

this range. pH showed direct correlationship with total alkaline and inverse relationship with CO_2.

The Maximum value of total alkalinity was found 282.0 mg/l. and munimum value 210mg./l. in month of August in both the years. It is produced by anions mainly carbonatates, bicorbonates and Hydroxyle-ions. The high value of total alkalinity was observed during summer season due to low level of water, concentration of carbonates along with decomposition of organic matter at station III in June. A significant positive correlation was registered with pH, total hardness, which shows positve relationship with productivity of water.

The hardness is frequently used as an assessement of the quality of water. The maximum value was noticed 240 mg/l and minimum value was found 150 mg/l in the month of August in both the years due to more diluation of water, less evaporation. The maximum value of hardness was found at station-III in month of June due to human activities and domestic nala. Hard water usually consists of Calcium, Magnesium ions, and possibly other dissolved compounts such as bicarbonates and sulfates. A positive correlation was found with T.A.at most of the stations.

The chlorides are found in appreciable amount in almost all natural waters. The maximum value was found 9.10 mg/l and minimum value was observed 1.85 mg/l. in the month of August due to dilution effect in rainy season. Higher value of Cloride also recorded in the month of May due to washing, bathing and other extraneous sources. The chloride contents showed direct relationship with Phytoplankton and inverse relationship with zooplankton.

Dissolved oxygen is one of the most important factor the maintenance and

distribution of biota in equatic ecosystem. The maximum value was observed 7.95 mg/l and minimum value was found 4.10 mg/l in the month of June due to high temperature and low water level which decreases the oxygen holding capacity of water. The highest value of D.O. was observed during winter season due to low temp., and much water quantity. It is one of the most important and critical parameter for the assessment of water quality, D.O. plays very important role in Physiology of biota. and bacterial activities decreased D.O. and increased B.O.D. in the river water. It showed direct relationship with Phytosynthesis and positively related with fish productivity which negative correlation with temperature, B.O.D, and C.O.D.

The biochemical oxygen demand gives an idea about the extent of pollution. The maximum value noted 2.15 mg/l and minimum value was found 0.05mg/l in the month of August. Maximum value of B.O.D. was observed in the month of June, at Station IV due to high temperature, decomposition of organic matter and waste discharges. B.O.D. is directly related with bacterial activities and showed positive correlation with C.O.D. and temperature. High B.O.D. is organic pollution indicator B.O.D has been the most widely used single parameter to estimate the biologically utilizable organic matter.

Chemical oxygen Demand is helpful in indicating toxicity of water which will be harmful for aquatic biota as well as health hazards by drinking such water. The maximum value was observed 14.10 mg/l and minimum value was found 0.00 mg/l in the month of August in both the years due to low temperature and less density of organic matters. The highest value was observed in summer season at IV due to high temperature, low water level and much organic concentration. The C.O.D. showed positive correlation with B.O.D. and temperature. It is an important parameter for estimating the carboneous fraction of the organic matter and is

measured in terms of oxidizability of the organic matter by chemical oxidants such as potassium permagnate and potassium dichromate. It's value fluctuated from season to season.

Amonical nitrogen is indicator of pollution level of the Aquatic body. The maximum value was observed 13.10 mg/l and minimum value was noticed ranged 0.00 mg/l in August in the both the years. High concentration was found in summer season of June due to high temperature, high alkalinity, animal excreta, and decomposition of organic matter. It was showed positively correlation with temperature, nitrate and nitrite.

The maximum concentration of nitrite was found 0.0380 mg/l and minimum value was observed 0.00 Mg/l in the month of August. Nitrite showed a positive correlationship with nitrate, phosphate and chloride. Nitrite is toxic to man and animals.

The Nitrate level was observed a maximum value of 2.20 Mg/l and minimum value was found 1.00 Mg/l in the month of August. Nitrite showed a positive correlationship with nitrate, Phosphat and chloride. Nitrite is toxic to man and animals.

The Nitrate level was observed in the Maximum ranged of 2.20 Mg/l and minimum value was found in 1.00 Mg/l in the month of August. Higher Concentration of nitrate is useful in irrigation. The nitrates are the end product of the biochemical oxidation of ammonia. It showed positive correlation with sulphate.

Phosphate is the limiting factors as its difficiency lowers the productivity of aquatic flora. The maximum value was found 0.0489mg/l. and minimum value was observed 0.0007 Mg/l in the month of February. The highest value of Po_4 was

observed at station III in August due to agricultural run off, discharge sewage and domestic wastes. It is positively related with ammonical nitrogen.

Sulphate is an important constituent of hardness with Calcium and Magnesium. The maximum value was observed 3.89Mg/l and minimum value was found 0.42 Mg/l in the month of August in both the years. Higher concentration was found in summer seasons June at station IV due to much domestic sewage and presence of rocks. It plays an important role for the growth of flora fauna. It showed positive correlation with phosphate and Sodium.

Sodium is present in all natural waters. The maximum value was found in the range of 40.00 Mg/l and minimum value was obsered 6.00Mg/l in winter season in the month of January throughout the study span. Higher concentration was found in rainy season in the month of August at station IV due to discharges points. Sodium was always found to be more than the potassium and It is essential to sustain fish life.

Potassium is an important element and plays a vital role in the metabolism of fresh water organisms and acts as an enzyme activator. Maximum value was found in the range 38.12 Mg/l and minimum value was observed in the range of 1.50 Mg/l in the winter season. The highest value was observed in rainy season in August at station III due to deposition of westes and bathing activities. Potassium showed positive correlation with sodium and hardness at some places.

The maximum value of CO_2 was found 5.40 Mg/l and Minimum value was observed 1.40Mg/l in the month of January in both the years. Highest value found in the month of June at station II due to respiration of living organisms, high temperature and much organic matter. Corbon-di-oxide showed positive correlation

with temperature and also showed inverse relationsship with D.O. and pH. high CO_2 caused toxic to fish and drinking water.

Fluoride is an ion and major natural source of fluoride is natural weathering of rocks. The maximum value was observed in the range of 0.78 Mg/l and minimum value was found 0.00 Mg/l in the month of November in both the year. It's highest value was found in rainy season due to leaching of soil and the speed with which water flows, domestic sewage. It's toxicity is harmfull for drinking water and fish productivity. Although primarily fluoride is the agent responsible for determining the occurrence of fluorosis in the community. Fluoride which is a pollutant interferes with the growth of the fish and thus may affect fish production and toxicity of human's bones.

Aquatic ecosystem is also directly affected by climatic factors i.e. light temperature and wind velocity. These factors were not only affected the Physico-chemical properties of water but also regulate the behaviour and activity of flora and fauna. Physical factors like light and heat are slowly responsible for many of the Phenomena like thermal stratification, chemical stratification and seasonal variation.

An analysis of the seasonal variation in the Physico-chemical characteristics of the water bodies showed that nearly all the parameters exhibited considerable differences.

The knowledge of relationship between microorganisms and ecological factors can be used as an indicator of environmental pollution. Microorganism, bacteria and algae are living catalysts that enable a vast number of chemical processes to occur in water and soil. A majority of important chemical reaction that take place

in water particularly those involving organic matter and oxidation-reduction processes occur through bacteria intermediaries. So the presence of micro organism represents the quality of water or the pollution status and condition of water.

Bacteria of the coliform group are considered as excellent indicator of faecal pollution and it is for that reason they are widely used as indicator of water quality. The maximum range 1789.0/100 ml and minimum range 55/100ml. in winter season in the month of January due to low temperature and lack of run off. Higher count of bacteria was noticed in summer and monsoon seasons at station IV. Due to high temperature which hences the decomposition of organic matter, pollutants run off, and sewage from nearby area as a result of the washing of soil and organic matter etc. It is directly correlated with the pollution, but the environmental conditions have a marked effect on the rate course, and extent of the self purification brought about in stream by bacterial activity. Bacteria found in river waters are dangereous to health on account of the poisonous toxins. The high count of bacteria signifies the organic pollution in the river water of Mandakini which is unpotable.

Regarding, biological characteristics of river water, the flora, and fauna were studied which are Phytoplankton and zooplankton, aquatic weeds and economically important fishes, qualitatively and quantitatively in the period of study (Jan. 2005-Dec. 2006).

Chlorophyceae, bacillariophyceae, Mixophyceae (Cynophyceae) groups of Phytoplanktons were observed in river water.

Phytoplankton of the river are generally composed of a wide variety of forms which are greatly affacted by the surrounding environment.

A number of members belong to chlorophyceae Bacillariophyceae, cyanophyceae were observed at the site. In chlorophyceae, 12 members i.e.

Ankistrodesumus, Chlorella, Cosmorium, Eudoirina, Hydrodicton, Microspora, Mougeotia, Pandorina, Pediastrum, Spirogyra, Ulothrix, Zyognema, were observed at this site. In Bacillariophyceae, 8 members i.e. Amphipleura coconies, Fragillaria, Gomphonema, Nitchia, Palaea, Synedraacus, Tabelloeria, Pinnularia were observed at this site.

In cynophyceae, 7 members i.e. Agmenellum, Anabaena, Cylinderos pernum, Rivularia, Microcoleus, Vaucharia, Phormidium were observed at this site. So in total 27 species were identified. The lowest population was observed in rainy season and highest population was observed in summer season in June due to high temperature and high dissolved organic matter. They impact colour to the water.

Phytoplankton density also revealed a positive correlation with some important Physico-chemical properties such as D.O. Nitrate, Phosphate and sulphate whereas BOD and COD indicated a negative correlation with Phytoplankton density.

In the present study the zooplankton were comprised of protozoa, rotifera, copepoda and cladocera. They are the primary consumers in the food chain. Protozoa were observed 7 genera; rotifera were observed 5 Genera, copepoda were noticed qualitatively 6 Genera and cladocera were observed 5 Genera. Their maximum number were found in the month of June due to high temperature, high turbidity and discharge more organic matter. The summer peak of zooplankton might be due to high temperature, pH, alkalinity and some other important nutrients have directly or indirectly favoured the development of zooplankton population. They are positively related with phosphate, nitrate, Photoperiod and water temperature.

The aquatic weeds were observed during the study period in the Mandakini river and found free floating, submerged and emergent. It was observed that the free

floating species are Lemna, Paucicostata, Nypheaea, Stellata, Pisitia, Eichhoornia crassipes, Azolla species etc. Appeared on the surface of the water and their growth started from October to February. whereas submerged species Hydrilla, Vallisnernia, Najas, Nechamandra, Isoetes, Cyperns, Chara, Speds were observed in monsoon period and are found in shallowest part of river.

In the present study course, fishes are most economically important group of vertebrate. There were 33 species and 14 families recorded in the river. Labeo calbases, Labeo rohita, Catla-Catla, Hetropheustes fossilis, wallago attu, Channa punchtatus, Notopterus chitala, Mastacembelus armatus were more abundant species in river Mandakini. Fishes are found at station-I Satiansuiya has more fish due to deepness of station, vast water bodies for the fish movement land station-III is shallow and less number of fishes.

The importance of fish culture as a source of food production. Besides being used as food. Fishes are an important source of oil containing vitamins A and D. their body oil is used in soap industry and tanning. Fish are major component of most aquatic habitats and water pollution affects all aquatic organisms including fish. They often are the primary indicators of pollution of river. Water pollution affects all the vital organs of the fish body and their effect may be histopathological, biochemical and physiological.

The major problems associated with sewage were the production of odours and spread of enteric disceases, besides organic pollution, which leads to oxygen depletion and fish killing.

Some time the effect of these elements as pollutent remains unexposed and people couldn't mark it but in longer run perceive a visible change in health and

hygiene of the society. This may result into increase in case of cancer, obesity and genetic abnormalities.

Conclusion, Aim and Recommendations

Having in view the present investigation of the river Mandakini it is concluded that it is perennial shallow and polluted as the river waters is primarily used to satisfy the daily needs of the living world. But it is also unpotable for drinking irrigation and aquatic fauna without any treatment due to its poor physico-chemical and biological properties. The problem of water pollution due to domestic sewage and and organic effluents, drainage is attaining greater dimensions day by day in Satna district M.P. Polluted water not only affects animal life but also affects vegetation also. Effective management of water resources controls its quality and to make this water suitable for drinking and fish fauna.

The river Mandakini is shallow, due to which fish fauna is not rich but aquatic weeds are found more. Fish were to some extent much in number due to the muddy bed and greenish colour of the river due to plankton density. In Mandakini river the water is found moderately hard.

The main aim of the study is to maintain the water body preserve for drinking purpose and suitable for the aquatic biota. On the basis of the present findings the following recommendations are made-:

1. Sewar lines should be checked regularly, and establishment of sewage treatment plants and transperation of the sewage from the pumping stations to the sewage treatment plants to treat the sewage before it is discharged in to the river.

2. Polythin and other solid waste product should be totaly prohibited throwing in river, for this pits be constructed along with strict orders for their use only.

3. During the religious festivals and mass basthing occasion as Kumbh, Amavashya etc. it is advisoble that the administration should make temporary lavotaries.

4. To save Mandakini awairness to the people at the time of large gathering awairness should be given through camps.

5. Algae and aquatic weeds should be removed time to time and seasonally through local public co-oparation. so that the water circulation as well as free movement of fishes and aquatic biota might be possible for their betterment.

6. Physico-chemical and biological characteristics of river Mandakini should be analysed time to time findout in the pollutents.

7. Flood causes soil erosion be checked by disallowing deforestation and by doing plantation on river basin.

Though the river water in its long run has the self purification quality but the pollution load is so much that still the rivers remain polluted. So, the above mentioned recommendations by planing should be executed, which is the only solution for improving the river water quality. The public and particularly, the industries sector and government have to work co-operatively with mutual understanding in order to maintain ecological, quality and holiness of the river Mandakini.

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